WL-TR-93-3043
This Report Supersedes WL-TR-91-3039

MISSILE DATCOM

USER'S MANUAL - REVISION 6/93

Keith A. Burns
Kenneth J. Deters
Stan L. Stoy
Steven R. Vukelich
McDonnell Douglas Aerospace
P.O. Box 516
St Louis, Missouri 63166

William B. Blake
Wright Laboratory (FIGC)
2210 Eighth St, Suite 21
Wright-Patterson Air Force Base, Ohio 45433-7531

JUNE 1993
FINAL REPORT FOR PERIOD AUGUST 1992 - MARCH 1993

FLIGHT DYNAMICS DIRECTORATE
WRIGHT LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AIR FORCE BASE, OHIO 45433-7562

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This technical report has been reviewed and is approved for publication.

WILLIAM B. BLAKE
Project Engineer
Control Dynamics Branch
Flight Control Division

FRANK R. SWORTZEL, Chief
Control Dynamics Branch
Flight Control Division

DAVID P. LEMASTER, Chief
Flight Control Division
Flight Dynamics Directorate

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
JUNE 1993

3. REPORT TYPE AND DATES COVERED
FINAL, 08/01/92 -- 03/31/93

4. TITLE AND SUBTITLE
MISSILE DATCOM USER'S MANUAL - REVISION 6/93

5. FUNDING NUMBERS
C F33615-89-D-2198
PE 62201
PR 2403
TA 05
WU 97

6. AUTHOR(S)
K.A. BURNS, K.J. DETERS, S.L. STOY, S.R. VUKELICH, AND W.B. BLAKE

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
MCDONNELL DOUGLAS AEROSPACE
P.O. BOX 516
ST LOUIS, MO 63166

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
FLIGHT DYNAMICS DIRECTORATE
WRIGHT LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB, OH 45433-7562

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
WL-TR-93-3043

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
THIS REPORT IS A USER'S MANUAL FOR THE 6/93 VERSION OF THE MISSILE DATCOM COMPUTER PROGRAM.

14. SUBJECT TERMS
MISSILE, AERODYNAMICS, STABILITY AND CONTROL

15. NUMBER OF PAGES
240

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

PREFACE

This report was prepared for the Flight Dynamics Directorate of the Wright Laboratory and the Foreign Aerospace Science and Technology Center, Wright-Patterson AFB, Ohio under Contract F33657-89-D-2198. It documents Missile Datcom Revision 6/93. The work was performed by the McDonnell Douglas Aerospace, St Louis, Missouri, a division of the McDonnell Douglas Corporation. The period of performance was August 1992 to January 1993. Joseph W. Herrmann and William B. Blake served as the Air Force project engineers. This report supersedes WL TR-91-3039, produced under Contract F33615-87-C-3604, which documents Missile Datcom Rev 4/91.

A list of the Missile Datcom principal investigators and individuals who made significant contributions to the development of this program is provided below.

PRINCIPAL INVESTIGATORS:
Steven R. Vukelich
Stan L. Stoy
Andrew A. Jenn
Kurt D. Bausch
John E. Williams
Keith A. Burns

CONTRIBUTORS:
Jerry E. Jenkins
Frank M. Sawyer
Charles B. Heath
William B. Blake
Richard D. Samuels
Joseph W. Herrmann
Kevin D. Bruns
Marvin E. Moore
Kenneth J. Deters

The Flight Dynamics Directorate is committed to the continuing development of Missile Datcom. The development is dependent to a large extent on users' feedback. Questions about the program or suggestions for future improvements to the program should be directed to Mr. William Blake, WL/FIGC, 2210 Eighth St Ste 21, Wright-Patterson Air Force Base, OH 45433-7531, phone (513) 255-6764.

BACKGROUND TO MISSILE DATCOM

Missile Datcom Revision 6/93 is the sixth in a series of releases.

In the late 1970's, the Tri-Service committee on Missile and Projectile Aerodynamics defined the need for a Missile Datcom type prediction tool. The Air Force was chosen as the lead service for the effort. A contract was subsequently awarded to the McDonnell Douglas Astronautics Company (F33615-80-C-3605) to recommend specific methods for inclusion into a potential computer program and identify areas where further work was needed. The final report from this effort, "Development Feasibility of Missile Datcom," (AFWAL-TR-81-3130) was published in October 1981.

In September 1981, The Missile Datcom Development Contract, (F33615-81-C-3617) was awarded to the McDonnell Douglas Astronautics Company. It subdivided the effort into four distinct phases. The initial release of the program in August 1984 presented the "Phase I" interim capability. Cases run using this version were limited to axisymmetric bodies with no more than eight fins total (two sets with up to four fins each).

The second release of the program (Rev 11/85) represented the "Phase IV" capability. This was the final version generated under contract F33615-81-C-3617. It added capability for elliptic bodies, inlets at supersonic speeds, dynamic derivatives, experimental data substitution, and configuration incrementing. It also increased the permissible number of fins to 32 (4 sets with up to 8 fins each). Two volumes of documentation (User's Manual and Program Implementation Guide), dated November 1985, were printed.

The third release (Rev/ 12/88) coincided with the publishing of AFWAL TR-86-3091 This version expanded the experimental data substitution option and dynamic derivative capability. Error from the 11/85 version were also corrected. Volume I of TR-86-3091 (Final Report) discusses the methods selected for incorporation into Missile Datcom. Volume II (User's Manual) is an updated version of the November 1985 manual. These reports are available from DTIC as ADA-211086 and ADA-210128 respectively.

The fourth release (Rev 7/89) added little new capability; its primary purpose was to correct coding errors, expand the body-alone dynamic derivative capability, and modify the equivalent angle-of-attack formulation. No new documentation was published.

The fifth release (Rev 4/91) followed contracted efforts with Nielsen Engineering and Research (F33615-86-C-3626) and the McDonnell Douglas Missile Systems Company (F33615-87-C-3604). This version expanded the inlet capability to subsonic speeds, added methods for inlet additive drag, base plume effects, and body protuberances.

Many other methods were improved and coding errors were corrected. The User's Manual for the 4/91 revision, WL-TR-91-3039, reflected these changes and is available from DTIC as ADA-237817.

The 6/93 version of the program is the end product an effort to further extend the capability of the code and expand the user's manual. This work was performed by McDonnell Douglas Aerospace under contract F33657-89-D-2198. The major changes to the program and associated reference material are listed below:

(a) The program was modified to be compatible with Unix based workstations.

(b) A method for trailing edge flap effectiveness has been added. The method is valid at subsonic (ref. 1) and supersonic (ref. 2) speeds. A cubic fairing between these results is used in the transonic region ($0.8 < \text{Mach} < 1.4$).

(c) The fin-body carryover interference calculation has been expanded to include the effect of fin dihedral (ref. 3).

(d) The inlet method has been expanded to treat semi-submerged shapes.

(e) The base drag calculation for boattails and flares has been modified.

(f) Coding errors have been corrected.

(g) The information in the original Program Implementation Guide (printed November 1985) has been updated and included as part of this User's Manual.

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1. Hoak, D.E., et al. "USAF Stability and Control Datcom," AFWAL TR-83-3048, October 1960 (revised 1978).

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1.0 INTRODUCTION

In missile preliminary design it is necessary to quickly and economically estimate the aerodynamics of a wide variety of missile configuration designs. Since the ultimate shape and aerodynamic performance are so dependent upon the subsystems utilized, such as payload size, propulsion system selection and launch mechanism, the designer must be capable of predicting a wide variety of configurations accurately. The fundamental purpose of Missile Datcom is to provide an aerodynamic design tool which has the predictive accuracy suitable for preliminary design, and the capability for the user to easily substitute methods to fit specific applications.

2.0 PROGRAM CAPABILITIES

The computer code is capable of addressing a wide variety of conventional missile designs. For the purposes of this document, a conventional missile is one which is comprised of the following:

- An axisymmetric or elliptically-shaped body
- One to four fin sets located along the body between the nose and base. Each fin set can be comprised of one to eight identical panels attached around the body at a common longitudinal position
- An airbreathing propulsion system.

To minimize the quantity of input data required, commonly used values for many inputs are assumed as defaults. However, all program defaults can be overridden by the user in order to more accurately model the configuration of interest.

The following paragraphs detail the configurations that can be analyzed. Later paragraphs describe the range of aerodynamic coefficients that can be predicted. Finally, the program constraints are discussed.

2.1 ADDRESSABLE CONFIGURATIONS

The following configurations can be analyzed:

- Circular or elliptically-shaped cross section bodies, with or without airbreathing inlets
- Fin alone (1 to 8 panels attached at the root)
- Body and up to 4 fin sets (1 to 8 panels in each fin set)
- The body and fin set configurations with deflected fins

Certain restrictions exist due to method limitations and are summarized in the following paragraphs.

2.1.1 Axisymmetric or Elliptical Bodies

Methodology is incorporated that permits analysis of the configuration components summarized in Table 1. Due to the types of methods selected restrictions also apply to the manner in which these components are joined to form a complete configuration:

- Subsonic/transonic speeds - The aerodynamic methods assume that the body is, as a minimum, composed of a nose-cylinder combination. The afterbody (boattail or flare) is optional, but if used, it must be attached to a cylindrical center body whose length is at least four body diameters; this restriction minimizes nose flow field coupling over the afterbody. If an afterbody is specified it must not be cylindrical, e.g., the base diameter must be different than the centerbody diameter. Table 2 summarizes the other restrictions on the configurations.

- Supersonic speeds - The aerodynamic methods used are not restricted to nose-cylinder combinations. Any arbitrary radii distribution can be defined since theoretical techniques are employed at Mach numbers above 1.2. Care should be taken to avoid introducing unexpected corners into the contour. If the contour has any concaved regions the marching may fail due to shock impingement on the body as it starts to curve out.

2.1.2 Panels

The program will accept inputs to describe most airfoil sections or planforms. Certain assumptions and limitations are made and summarized in the following paragraphs.

2.1.2.1 Airfoil Section - The program will accept virtually any symmetrical airfoil section or NASA subsonic cambered section. The airfoil section can be defined using a NACA designation or by supplying the coordinates of the section. Circular arc, hexagonal, or diamond shaped sections can also be specified. A symmetric hexagonal cross-section is the default; its shape is computed using the planform inputs. Hence, explicit definition of the airfoil section is optional. Although cambered airfoil sections can be input, their use in the code is currently limited to subsonic applications.

2.1.2.2 Planform - Each set of fins may be comprised of up to eight separate panels. It is assumed that each panel is geometrically identical. Although planforms may be described by up to 10 separate pieces or sections, an equivalent straight-tapered panel is computed and used at all speeds. There is no capability to specify a panel with outboard dihedral.

2.1.3 Airbreathing Inlets

Both axisymmetric and two-dimensional airbreathing inlet/diverter combinations can be defined. Up to 20 identical inlets can be positioned around the body at arbitrary angles. Vehicles with inlets can be analyzed at all speeds.

2.2 TYPES OF DATA COMPUTED

2.2.1 Aerodynamics

The program computes the following aerodynamic parameters as a function of angle of attack for each configuration:

C_N	Normal Force Coefficient
C_L	Lift Coefficient
C_m	Pitching Moment Coefficient
X_{cp}	Center of Pressure in calibers from the moment reference center
C_A	Axial Force Coefficient
C_D	Drag Coefficient
C_Y	Side Force Coefficient
C_n	Yawing Moment Coefficient
C_l	Rolling Moment Coefficient
$C_{N\alpha}$	Normal force coefficient derivative with angle of attack
$C_{m\alpha}$	Pitching moment coefficient derivative with angle of attack
$C_{Y\beta}$	Side force coefficient derivative with sideslip angle
$C_{n\beta}$	Yawing moment coefficient derivative with sideslip angle
$C_{l\beta}$	Rolling moment coefficient derivative with sideslip angle

The derivative output can be in degrees or radians. Partial output results, which detail the components used in the calculations, are also optionally available.

It should be noted that the drag force (and drag coefficient) is different between the wind and stability axes systems if the missile body is at a sideslip angle (β) to the wind. However, wind axis drag and stability axis drag are the same at zero sideslip. In Missile Datcom, drag force methods are assumed to be in the stability axes system and axial force methods are assumed to be in the body axes system unless otherwise noted.

The program has the capability to perform a static trim of the configuration, using any fin set for control with fixed incidence on the other sets. The two types of aerodynamic output available from the trim option are as follows:

- Untrimmed data - Each of the aerodynamic force and moment coefficients are printed in a matrix, which is a function of angle of attack and panel deflection angle. This output is optional.

- Trimmed data - The trimmed aerodynamic coefficients, and trim deflection angle, are output as a function of angle of attack.

2.2.2 Geometry

All components of the configuration have their physical properties calculated and output for reference if requested. All data is supplied in the user selected system of units.

2.2.3 Other

The reference area and reference length are user defined. The user may optionally select to print the calculated body or fin pressure coefficient distributions at supersonic speeds. Outputs of the partial aerodynamic results and a summary of method extrapolations are also optionally available.

2.3 OPERATIONAL CONSIDERATIONS

The code has been written to conform to the coding standards for the American National Standards Institute (ANSI) Standard FORTRAN X3.9-1978, often referred to as FORTRAN V or FORTRAN 77.

There are only four exceptions to the ANSI standards used in the code:

- Transfer on end-of-file - The FORTRAN IV statement IF(EOF(UNIT).NE.0) is used in the standard CDC compatible code. The FORTRAN V statement END=label in the

FORTRAN READ statements is incorporated in the code, but is inactive in the CDC code.

- NAMELIST - The use of namelist for input and output (I/O) is used. Although this appears to be a violation of FORTRAN IV, it is really not since a namelist emulator has been written for the Missile Datcom code using FORTRAN IV.

- Mathematical functions - A few mathematical functions are not considered "standard," such as the trigonometric tangent. Standard FORTRAN equivalents for these functions are available on request.

- PROGRAM card - The code was developed on the Control Data Corporation CYBER computers. This system requires that the first card of the main routine be a PROGRAM statement. An IBM or VAX compatible version of the code is also maintained which has a different format for the program card.

3.0 INPUT DEFINITION

Inputs to the program are grouped by "case". A "case" consists of a set of input cards which define the flight conditions and geometry to be run. Provisions are made to allow multiple cases to be run. The successive cases can either incorporate the data of the previous case (using the input card SAVE) or be a completely new configuration design. The SAVE feature, for example, permits the user to define a body and wing (or canard) configuration in the first case and vary the tail design for subsequent cases.

The scheme used to input data to the computer program is a mixture of namelist and control cards. This combination permits the following:

- Inputs are column independent and can be input in any order.

- All numeric inputs are related to mnemonic (variable) names.

- Program input "flags" are greatly reduced. Required "flags" are identified by a unique alphabetic name which corresponds to the option selected.

The program includes an error checking routine which scans all inputs and identifies all errors. This process is a single-pass error checking routine; all errors are identified in a single "run". In addition, the program checks for necessary valid inputs, such as a non-zero Reynolds number. In some cases, the code will take corrective action. The type of corrective action taken is summarized later in this section.

Flexibility has been maintained for all user inputs and outputs. The following summarize the program generality available:

- The units system can be feet, inches, meters or centimeters. The default is feet.

- Derivatives can be expressed in degree or radian measure. Degree measure is the default.

- The body geometry can be defined either by shape type or by surface coordinates.

- The airfoil can be user defined, NACA, or supersonic shaped sections. The NACA sections are defined using the NACA designation. A hexagonally shaped supersonic section is the default.

- The configuration can be run at a fixed sideslip angle and varying body angle of attack, or a fixed aerodynamic roll angle and varying total angle of attack.

- The flight conditions can be user defined, or set using a Standard Atmosphere model. The capability to define wind tunnel test conditions as the flight conditions is also available. The default flight condition is zero altitude.

3.1 NAMELIST INPUTS

The required program inputs use FORTRAN namelists. Missile Datcom is similar to other codes which use the namelist input technique, but differ as follows:

- Namelist inputs are column independent, and can begin in any column including the first. If a namelist is continued to a second card, the continued card must leave column 1 blank. Also, the card before the continued card must end with a comma. The last usable column is number 79 if column 1 is used, and column 80 if column 1 is blank.

- The same namelist can be input multiple times for the same input case. The total number of namelists read, including repeat occurrences of the same namelist name, must not exceed 300.

  The three namelist inputs

  ```
  $REFQ    SREF=1.,$
  $REFQ    LREF=2.,$
  $REFQ    ROUGH=0.001,$
  ```

  are equivalent to

  ```
  $REFQ    SREF=1.,LREF=2.,ROUGH=0.001,$
  ```

- The last occurrence of a namelist variable in a case is the value used for the calculations.

The three namelist inputs

```
$REFQ      SREF=1.,$
$FLTCON    NMACH=2.,MACH=1.0,2.0,$
$REFQ      SREF=2.,$
```

are equivalent to

```
$REFQ      SREF=2.,$
$FLTCON    NMACH=2., MACH=1.0, 2.0,$
```

- The namelists can be input in any order.
- Only those namelists required to execute the case need be entered.
- Certain hollerith constants are permitted. They are summarized in Table 3. Note that any variable can be initialized by using the constant UNUSED; for example, LREF=UNUSED sets the reference length to its initialized value.

All Missile Datcom namelist inputs are either real numbers or logical constants. Integer constants will produce a nonfatal error message from the error checking routine and should be avoided.

The namelist names have been selected to be mnemonically related to their physical meaning. The ten namelists available are as follows:

Namelist	Inputs
$FLTCON	Flight Conditions (Angles of attack, Mach numbers, etc.)
$REFQ	Reference quantities (Reference area, length, etc.)
$AXIBOD	Axisymmetric body definition
$ELLBOD	Elliptical body definition
$PROTUB	Protuberance information and geometry
$FINSETn	Fin descriptions by fin set (n is the fin set number; 1, 2, 3 or 4)
$DEFLCT	Panel incidence (deflection) values
$TRIM	Trimming information
$INLET	Inlet geometry
$EXPR	Experimental data

Each component of the configuration requires a separate namelist input. Hence, an input case of a body-wing-tail configuration requires at least one of each of the following namelist inputs, since not all variables have default values assigned:

$FLTCON	to define the flight conditions
$AXIBOD or $ELLBOD	to define the body
$FINSET1	to define the most forward fin set
$FINSET2	to define the first following fin set
$FINSET3	to define the second following fin set
$FINSET4	to define the third following fin set

The following namelists are optional since defaults exist for all inputs:

$REFQ	to define the reference quantities
$PROTUB	to define protuberance option inputs
$DEFLCT	to define the panel incidence (deflection angles)
$TRIM	to define a trim case
$INLET	to define inlet geometry
$EXPR	to define experimental input data

Defaults for all namelists should be checked to verify the configuration being modeled does not include an unexpected characteristic introduced by a default.

The following sections describe each of the namelist inputs. Each section is accompanied by a figure which summarizes the input variables, their definitions, and units. Since the system of units can be optionally selected, the column "Units" specifies the generic system of units as follows:

L	Units of length; feet, inches, centimeters or meters
F	Units of force; pounds or Newtons
deg	Units of degrees; if angular, in angular degrees; if temperature, either degrees Rankine or degrees Kelvin
sec	Units of time in seconds

Exponents are added to modify the above. For example, L^2 means units of length squared, or area. Combinations of the above are also used to specify other units. For example, F/L^2 means force divided by area, which is a pressure.

Since it is difficult to discern the difference between the number zero "0" and the alphabetic letter "O", it should be noted that none of the namelist or namelist variable names contain the number zero in them. In general, the number zero and the letter "O" are not interchangeable unless so stated.

The program ascertains the configuration being modeled by the presence of each component namelist, even if no data is entered. The following rules for namelist input apply:

- Do not include a namelist unless it is required. Once read, the presence of a namelist (and, hence, a configuration component) can only be removed using the DELETE control card in a subsequent case. Simply setting all variables to their initialized values will *not* remove the configuration component.

- Do not include a variable within a namelist unless it is required. Program actions are often determined from the number and types of input provided.

- Do not over-specify the geometry. User inputs will take precedence over program calculations. Inputs that define a shape that is physically impossible will be used as specified. The program does not "fix-up" inconsistent or contradictory inputs.

3.1.1 Namelist FLTCON - Flight Conditions

This namelist defines the flight conditions to be run for the case. The program is limited to no more than 20 angles of attack and 20 Mach numbers per case at a fixed sideslip angle, aerodynamic roll angle, altitude, and panel deflection angle. Therefore, a "case" is defined as a fixed geometry with variable Mach number and angles of attack.

The inputs are given in Figure 1. There are two ways in which the aerodynamic pitch and yaw angles can be defined:

- Input ALPHA and BETA. If BETA is input and PHI is not, it is assumed that the body axis angles of attack (α) and sideslip angles (β) are defined.

- Input ALPHA and PHI. If PHI is input and non-zero, it is assumed that ALPHA is the total angle of attack (α) and PHI is the aerodynamic roll angle (ϕ).

- Input ALPHA, BETA and PHI. The value for BETA is ignored if PHI is non-zero.

As a minimum the following variables must be defined:

NALPHA	number of angles of attack to run (NALPHA $\geq$ 2)
ALPHA	angle of attack schedule (matching NALPHA)
NMACH	number of Mach numbers or speeds (NMACH $\geq$ 1)
MACH or VINF	Mach number or speed schedule (matching NMACH)

The REN, TINF and PINF data must correspond to the MACH or VINF inputs. The ALPHA and MACH dependent data can be input in any order; the code will sort the data into ascending order.

Reynolds number is always required. Three types of inputs are permitted to satisfy the Reynolds number requirement:

- Specify Reynolds number per unit length using REN
- Specify the altitude using ALT, and the speed using MACH or VINF (Reynolds number is computed using the Standard Atmosphere model)
- Specify pressure and temperature using PINF and TINF, and the speed using MACH or VINF (typical of data available from a wind tunnel test)

User supplied data will take precedence over program calculations. Hence, the user can override any default or Standard Atmosphere calculation. The default condition is sea-level altitude (ALT=0.) if the wrong combination of inputs are provided and the Reynolds number cannot be calculated.

3.1.2 Namelist REFQ - Reference Quantities

Inputs for this namelist are optional and are defined in Figure 2. A vehicle scale factor (SCALE) permits the user to input a geometry that is scaled to the size desired. This scale factor is used as a multiplier to the user defined geometry inputs; it is not applied to the user input reference quantities (SREF, LREF, LATREF). If no reference quantities are input, they are computed based upon the scaled geometry. XCG is input relative to the origin (X=0) and is scaled using SCALE.

In lieu of specifying the surface roughness height ROUGH, the surface Roughness Height Rating (RHR) can be specified. The RHR represents the arithmetic average roughness height variation in millionths of an inch. Typical values of ROUGH and RHR are given in Table 4.

3.1.3 Namelist AXIBOD - Axisymmetric Body Geometry

An axisymmetric body is defined using this namelist. The namelist input variables are given in Figures 3a and 3b and a sketch of the geometric inputs are given in Figure 4. The body can be specified in one of two ways:

> OPTION 1: The geometry is divided into nose, centerbody, and aft body sections. The shape, overall length, and base diameter for each section are specified. Note that not all three body sections need to exist on a configuration; for example, a nose-cylinder configuration does not require definition of an aft body.
>
> OPTION 2: The longitudinal stations and corresponding body radii are defined, from nose to tail. This option should only be selected if the Mach number is greater than 1.2.

If Option 2 is selected, the program generates a body contour based on the user specified values of X, R, and DISCON. Many additional points in between the user specified input coordinates will be generated. The resulting contour can contain more than 1000 points. If the PRINT GEOM BODY control card is used, this contour will be written to tape unit 3.

The program uses the input value for NX to determine which option is being used. If NX is not input then Option 1 inputs are assumed. If both shapes and body coordinates (Options 1 and 2) are used, the body coordinate information will take precedence. NX can be set to its initialized value (to simulate the variable as not input) by specifying "NX=UNUSED".

It is highly recommended that Option 1 be used when possible. The program automatically calculates the body contour based upon the segment shapes using geometry generators. Hence, more accurate calculations are possible. Even when Option 2 is used, appropriate Option 1 inputs should be included. This identifies where the code should insert break points in the contour. If these parameters are not input, they are selected as follows:

LNOSE	Length of the body segment to where the radius first reaches a maximum
DNOSE	The diameter at the first radius maximum
LCENTR	Length of the body segment where the radius is constant
DCENTR	Diameter of the constant radius segment
LAFT	The remaining body length
DAFT	Diameter at the base
DEXIT	Not defined (implies that base drag is not to be included in the axial force calculations)

If DEXIT is not input, or set to UNUSED, the base drag computed for the body geometry will not be included in the final computed axial force calculations. To include a "full" base drag increment, a zero exit diameter must be specified (DEXIT=0.).

If body coordinates are input using the variables NX, X, R, and DISCON, and the nose is spherically blunted, the geometry must be additionally defined using the following:

- BNOSE must be specified (even if zero)

- TRUNC must be set to .FALSE.

- The first five (5) points in the X and R arrays must lie on the spherical nose cap [i.e., X(1), X(2), X(3), X(4), X(5), R(1), R(2), R(3), R(4), and R(5) are spherical cap coordinates]

The following summarizes the input generality available:

- X(1) does not have to be 0.0; an arbitrary origin can be selected.

- Five shapes can be specified by name:

  CONICAL (CONE) - cone or cone frustrum (default for boattails and flares)
  OGIVE - tangent ogive (default for noses)
  POWER - power law*
  HAACK - L-V Haack (length-volume constrained)*
  KARMAN - von Karman (L-D Haack; length-diameter constrained)*

- If DAFT<DCENTR the afterbody is a boattail.**

- If DAFT>DCENTR the afterbody is a flare.**

- If LAFT is not input, aft body (boattail or flare) does not exist.

* applies to noses only
** DAFT must not be equal to DCENTR

The inputs for base-jet plume interaction effects are defined using Option 1. Incremental forces and moments due to jet induced boattail separation and separation locations on aft fins are calculated if these inputs are used.

- This option should only be run for supersonic cases (i.e. $M_\infty \geq 1.2$)

- The calculations will be done for three types of aft bodies conical boattail, ogival boattail, or cylindrical (i.e. no boattail). Error messages will be printed to the output file and the calculations skipped if any other aft body is defined.

- If BASE=.FALSE. or is not input the calculations will be skipped.

- DEXIT must not equal zero if this option is used.

- The jet Mach number (JMACH), jet to freestream static pressure ratio (PRAT), and jet to freestream stagnation temperature ratio (TRAT) must be specified for each freestream Mach number or velocity input in the namelist FLTCON. For subsonic or transonic freestream Mach numbers or velocities, dummy values must be input for JMACH, PRAT, and TRAT. The user must be careful to match these inputs with the proper freestream conditions.

- If a portion of the fins in a fin set are located on the boattail or base, the boattail separation locations will be calculated and output at each fin roll angle. However, if the fins do not extend to the boattail the separation locations will be skipped.

- Results may be inaccurate if excessive extrapolation is required. If extrapolation occurs, a warning message will be printed to the output file. To avoid extrapolation and minimize inaccuracy, the input parameters should be kept within the ranges shown in Figure 5.

3.1.4 Namelist ELLBOD - Elliptical Body Geometry

Elliptically-shaped cross section bodies are defined using this namelist. The inputs are similar to those for the axisymmetric body geometry (AXIBOD), and are shown in Figures 6a and 6b. The types of shapes available, and the limitations, are the same as those given for axisymmetric bodies. However, the base-jet plume interaction input options in namelist AXIBOD are not available in namelist ELLBOD. Please read Section 3.1.3 for limitations.

Note that the body cross section ellipticity can vary along the body longitudinal axis. Sections which are taller-than-wide and wider-than-tall can be mixed to produce "shaped" designs. The shape of the sections is controlled by the variables ENOSE, ECENTR, and EAFT or ELLIP, H and W.

3.1.5 Namelist PROTUB - Protuberance Geometry

Missile protuberances can be input using this namelist. Axial force coefficient is calculated for the protuberances and added to the body axial force coefficient. Figure 7 shows the inputs required. Figure 8 shows the different protuberance shapes available. The following defines the inputs required for protuberance calculations:

- NPROT is the number of protuberance sets. A protuberance set is made up of protuberances at the same axial location with the same size and shape. Therefore, it is only necessary to describe the geometry of one individual protuberance per set. The maximum number of protuberance sets is 20.

- NLOC is the number of protuberances in each protuberance set. NLOC accounts for the number of identical protuberances located around the missile body at a given axial location.

- The following equation helps to clarify the relationship between NLOC and NPROT:

  NLOC(1)+NLOC(2)+NLOC(3)+ . . . +NLOC(NPROT) = (Total number of protuberances on the missile)

- The axial location of a protuberance (XPROT) should be input at the protuberance geometric centroid. An approximation of the centroid will be adequate for the analysis. The location is used to calculate the average boundary layer thickness over the protuberance length.

- VCYL, HCYL, BLOCK, and FAIRING type protuberances have 1 member. LUG types have 4 members and SHOE types have 3 members. (Refer to Figure 8)

- All inputs for LPROT, WPROT, HPROT, and OPROT are in sequential order based upon the members specified with the protuberance type (PTYPE) input.

- The FAIRING type protuberance should always have a zero offset. The code will assume a zero offset even if a non-zero offset is input.

More complex protuberance shapes can be analyzed by a component build-up method. Each member is treated as a separate protuberance. Combinations of vertical cylinders, horizontal cylinders, and flat plates or blocks can be input at specified offsets from the missile body. If a FAIRING type protuberance is used in a component build-up, the offset should be zero. The user must manually add axial force of the individual members of the component build-up if the total protuberance axial force is desired.

Figure 9 shows an example input file for a missile with several protuberances.

3.1.6 Namelist FINSETn - Define Fin Set n

Figure 10a describes the variables needed to be input for fin set planform geometry descriptions. Optional fin cross-section inputs are described in Figure 10b. Special user specified fin cross-sections can be input using the variables in Figure 10c. The user may specify up to four non-overlapping fin sets. The variable "n" in the namelist specifies the fin set number. Fin sets must be numbered sequentially from the front to the back of the missile beginning with fin set one. An input error will occur if "n" is zero or omitted. The code allows for between 1 and 8 geometrically identical panels to be input per fin set. The panels may be arbitrarily rolled about the body and can be given dihedral.

Four types of airfoil sections are permitted--hexagonal (HEX), circular arc (ARC), NACA airfoils (NACA), and user defined (USER). Only one type of airfoil section can be specified per fin set, and this type is used for all chord wise cross sections from root to tip. Diamond-shaped sections are considered a special case of the HEX type; hence, hexagonal and diamond sections can coexist on the same panel. The airfoil proportions can be varied from span station to span station.

The user selects "break points" on the panel (Figure 11a). A "break point" specifies a change in leading or trailing edge sweep angle. Also a break point may specify a change in airfoil section, but the section must be of the same type (i.e., a change in section type cannot go from a NACA to an ARC) only the proportions can change. The location of each "break point" is defined by specifying its semi-span station (SSPAN) from the vehicle centerline and distance from the first body station to the chord leading edge (XLE). The "break point" chord leading edge array (XLE) can be defined by simply specifying the root chord leading edge [XLE(1)] and the sweep angles of each successive panel segment if the semi-span stations are input. Note that only those variables that uniquely define the fin need to be entered. Redundant inputs can lead to numerical inconsistencies and subsequent computational errors.

The panel sweep angle (SWEEP) can be specified at any span station for each segment of the panels. If STA=0., the sweep angle input is measured at the segment leading edge; if STA=1., the sweep angle input is measured at the segment trailing edge. Note that some aerodynamic methods are very sensitive to panel sweep angle. For small span fins, small errors in the planform inputs can create large sweep angle calculation errors. It is recommended that exact sweep angles be specified wherever possible; for example, if the panel trailing edge is unswept, specifying SWEEP=0. and STA=1. will minimize calculation error. Then the leading edge sweep will be computed by the code internally using the SSPAN and CHORD inputs.

Plain trailing edge devices may be modelled in Missile Datcom. This is accomplished via the CFOC array which is the flap chord to fin chord ratio, c_f/c. Trailing edge devices can be either full span or partial span subject to certain limits specified below. The trailing edge devices can not have a taper ratio greater than 1.0, and the hinge line must be strsight regardless of the number of segments comprising the trailing edge device. A partial span trailing edge device is specified by setting CFOC=0 for those chord/span stations that are not part of the trailing edge device. Examples of acceptable and unacceptable geometries are shown in Figure 11b as well as the corresponding input values for the variable arrays CFOC, CHORD and SSPAN. A special case where the trailing edge device extends to the tip of a fin with a taper ratio of zero is also shown in Figure 11b. While any value of CFOC will result in the correct flap chord at the tip (since the tip chord is zero), the user must specify a CFOC=1.0 since a value of CFOC=0 would indicate the trailing edge device does not exist at this chord/span station. the user should also be aware of the following:

- All trailing edge deflection angles are measured with respect to the freestream and not relative to the hinge line. This becomes an important distinction as the hinge line sweep angle is increased.
- The variable SKEW does not apply to trailing edge devices.
- The hinge moments for trailing edge devices are not calculated.
- The increase in profile drag due to trailing edge deflection is not calculated.

Since all panels are assumed to be planar (i.e., no tip dihedral), all inputs must be "true view". Once the planform of a single panel is defined, all fins of the set are assumed to be identical. The number of panels present is defined using the variable NPANEL. Each panel may be rolled to an arbitrary position around the body using the variable PHIF. PHIF is measured clockwise from top vertical center (looking forward from behind the missile) as shown in Figure 12. Each panel may also contain a constant dihedral. A panel has zero dihedral when it is aligned along a radial ray from the centerline (see Figure 12). The variable used to specify dihedral is GAM. GAM is positive if the panel tip chord is rotated clockwise.

Different aerodynamics will be computed depending upon whether the FLTCON namelist variable PHI, or the FINSETn namelist variable PHIF, is used to roll the geometry. Figure 13 depicts the usage of the roll options. The variable "PHI" means that the body axes system is to be rolled with the missile body, whereas PHIF keeps the aerodynamics in a non-rolled body axis, but rather locates the fin positions around the body. PHIF must be input for each panel, while PHI rolls the whole configuration.

It is the user's responsibility to assure that the fins are (1) on the body surface, and (2) do not lie internal to the body mold line. The program does not check for these peculiarities. If SSPAN(1)=0 is input, the program will assume that the panel semi-span data relative to its root chord are supplied. The code will automatically interpolate the body geometry to place the panel on the body surface with the root chord parallel to the body centerline. See Section 3.4 for modeling fins on body segments of varying radii.

When defining more than one fin set, the fin sets must never have their planforms overlap one another. There must be sufficient space between the forward fin trailing edge and aft fin leading edge to avoid violating the assumptions made by the aerodynamic computations. It is assumed by the aerodynamic model that the vortices are fully rolled up when they pass the control points of the next downstream set of fins. In reality the vortex sheet does not fully roll up until it is at least four semispans downstream. If two fin sets are closer than this the results may be in error since the use of a vortex filament model may introduce too much vorticity. The closer the spacing the larger the error may be. No algorithm error will result from too close a fin set spacing.

Panels with cut-out portions can be modeled by using one of the ten available fin segments as a transition segment. This is accomplished by giving the segment a small span, such as 0.0001, and specifying the segment root and tip chords to transition into the cut-out portion of the fin.

3.1.7 Namelist DEFLCT - Panel Deflection Angles

This namelist permits the user to fix the incidence angle for each panel in each fin set. The variables are given in Figure 14. Note that the panel numbering scheme is assumed to be that shown in Figure 12. The array element of each deflection array corresponds to the panel number.

The scheme for specifying deflection angles is unique, yet concise. The scheme used is based upon the body axis rolling moment:

"In Missile Datcom a positive panel deflection is one which will produce a negative (counterclockwise when viewed from the rear) roll moment increment at zero angle of attack and sideslip."

3.1.8 Namelist TRIM - Trim Aerodynamics

This namelist instructs the program to statically trim the vehicle longitudinally (C_m=0). The inputs are given in Figure 15. Note that only one fin set can be used for trimming. The user only specifies the range of deflection angles desired using DELMIN and DELMAX; the code will try to trim the vehicle for each angle of attack specified using the allowable fin deflections. This option will not trim the vehicle at a specific angle of attack if the deflection required is outside the range set by the values of DELMIN and DELMAX.

The deflection sign convention used is that described in Section 3.1.7; hence, DELMIN and DELMAX are input as if deflecting the panel to the maximum will produce a negative rolling moment from the panels resulting normal force increment. DELMIN must always be less than DELMAX.

A logical variable, ASYM, has been included to permit reverse panel deflections. For example, deflecting all panels in one sense results in a rolling moment and no pitching moment. The ASYM flag will permit analysis of an elevator (or pitch deflection) effect, by deflecting panels on one side of the vehicle only, with opposite panels mirroring those deflections. Since a maximum of eight panels are allowed in a fin set, only four panels of the fin set can be deflected in the reverse direction using the ASYM flag. Both trimmed and untrimmed results are available for output.

3.1.9 Namelist INLET - Axisymmetric and 2-Dimensional Inlet Geometry

This namelist is used to model the inlet and diverter geometry. Axisymmetric, two-dimensional side mounted, and two-dimensional top mounted inlets can be described. The inlets may be covered or uncovered and oriented in any position about the missile body. Inlet normal force, pitching moment, side force, yawing moment, and axial force are calculated. The methods are valid for subsonic, transonic, and supersonic speeds. Figure 16 shows the INLET namelist inputs, and Figures 17a, 17b, 17c and 17d show the inlet/diverter geometry for each type of inlet. The inlets may have a boundary layer diverter, be conformal (diverter height HDIV=0), or be semi-submerged (diverter height HDIV<0). The methods used for the inlets are the same regardless of wether the inlet has a diverter or is semi-submerged, and they are not applicable to chin inlets. The variable HDIV is used to determine whether a diverter exist. Figure 17d shows examples of two-dimensional and axisymmetric inlets that are conformal or semi-submerged.

- Inlet roll orientation uses the same convention as the fin panel roll orientation.

- Inlet height and width or inlet diameter is input at five axial locations described in Figures 17a, 17b, and 17c:
  1) leading edge or tip
  2) cowl lip leading edge
  3) midbody start
  4) boattail start
  5) boattail end

- If the inlet is covered (COVER=.TRUE.), no flow is allowed into the inlet. The inlet is plugged between stations 1 and 2, flush with the inlet face.

Inlet additive drag or spillage drag can be calculated for external compression inlets operating at off-design conditions ($M_{\infty}<M_{design}$) for Mach numbers greater than 1. Whenever flow spillage occurs, the mass flow ratio is less than one, and additive forces are generated on the deflected streamtube captured by the inlet. If the inlet operates on-design, the ramp shock lies on the inlet face and on the cowl lip. In these cases, the maximum mass flow ratio is one (zero spillage) and the minimum additive forces are zero.

- If the inlet is covered (COVER=.TRUE.), the additive drag calculations will be skipped.

- If ADD=.FALSE., or is not input the additive drag calculations will be skipped.

- Mass flow ratio (MFR) must be specified for each freestream Mach number or velocity given in namelist FLTCON. For Mach numbers less than 1, dummy values must be input for MFR. The user must be careful to match these inputs with the proper freestream conditions.

- The additive drag is calculated at zero angle of attack and assumed to remain constant for all angles of attack.

3.1.10 Namelist EXPR - Experimental Data Substitution

This namelist is used to substitute experimental data for the theoretical data generated by the program. The variables to be input are shown in Figure 18. Use of namelist EXPR does not stop the program from calculating theoretical data, but rather the experimental data is used in configuration synthesis, and it is the experimental data that is used for the component aerodynamics for which it is input.

Experimental data may be substituted for any configuration component or partial configuration. Experimental data is input at a specific Mach number. When using namelist EXPR, the case must be run at the Mach number for which you are substituting experimental data. However, the experimental data being input may have different reference quantities and a different center of gravity location than the case being run.

Experimental data input for a fin alone is input as panel data, not as total fin set data. The user should note that experimental data for fin alone $C_{m\alpha}$ is not used in the configuration synthesis process. Instead fin alone $C_{N\alpha}$ (the experimental value if input) is used to determine the fin contribution to $C_{m\alpha}$ during configuration synthesis. If body alone experimental data and body-fin experimental data are input for the same case the body data is ignored in configuration synthesis. If experimental $C_{m\alpha}$ data is input for a body + 1 fin set for a multi-fin set configuration, the calculated contributions to $C_{m\alpha}$ of the other fin sets are added to the experimental data.

Since the experir tal namelist forms the basis for configuration incrementing, the lateral uirectional coefficients are included to allow for sideslip cases. These coefficients are input the same as the longitudinal coefficients. However, if the lateral directional coefficients are input, the lateral directional beta derivatives will not be computed our output.

The following rules apply to the use of namelist EXPR.

- It is assumed that the coefficients in EXPR are for the same sideslip and/or aerodynamic roll as the case being run.
- Separate namelist EXPR must be specified for each Mach number.
- Each namelist EXPR must end with a $END card.
- Separate namelist EXPR must be specified for each partial configuration for which experimental data is to be input, (i.e., body, body + 1 fin set, etc)
- Separate namelist EXPR must be specified for each reference quantity change.

  Example:
  The user has experimental data available for a body + 2 fin set configurations and is interested in the effects of adding a booster containing a third fin set. he would then use namelist EXPR to input the experimental data. When the

configuration is synthesized, it would use the experimental data for body + 2 fin sets and theoretical data for fin set three.

3.2 CONTROL CARD INPUTS

Control cards are one line commands which select program options. Although they are not required inputs, they permit user control over program execution and the types of output desired. Control cards enable the following:

- Printing internal data array results for diagnostic purposes (DUMP)
- Outputting intermediate calculations (PART, BUILD, PRESSURES, PRINT AERO, PRINT EXTRAP, PRINT GEOM, PLOT, NAMELIST, WRITE, FORMAT)
- Selecting the system of units to be used (DIM, DERIV)
- Defining multiple cases, permitting the reuse of previously input namelist data or deleting namelists of a prior case (SAVE, DELETE, NEXT CASE)
- Adding case titles or comments to the input file and output pages (*, CASEID)
- Limits the calculations to longitudinal aerodynamics (NO LAT)

3.2.1 Control Card - General Remarks

A total of 42 different control cards are available. There is no limit to the number of control cards that can be present in a case. If two or more control cards contradict each other, the last control card input will take precedence. All control cards must be input as shown, including any blanks. Control cards can start in any column but they cannot be continued to a second card. Misspelled cards are ignored. Control cards can be located anywhere within a case.

Once input, the following control cards remain in effect for all subsequent cases:

DIM FT	DIM IN	DIM CM	DIM M	FORMAT
HYPER	INCREMENT	NOGO	NO LAT	PLOT
SOSE	WRITE			

The following control cards are effective only for the case in which they appear:

BUILD	CASEID	DAMP	DELETE
DUMP CASE	DUMP NAME	NAMELIST	PART
PRESSURES	PRINT AERO	PRINT EXTRAP	
PRINT GEOM	SAVE	SPIN	TRIM

These control cards can be changed from case to case:

DERIV DEG	DERIV RAD	NACA

The only control card that can be optionally saved, from case-to-case, is the NACA card.

3.2.2 Control Card Definition

Available control cards are summarized as follows:

<u>BUILD</u>

This control card instructs the program to print the results of a configuration build-up. All configurations which can be built from the components defined will be synthesized and output, including isolated data (e.g., body alone, fin alone, etc.). Component build-up data is not provided if the TRIM *option* is selected.

<u>CASEID</u>

A user supplied title to be printed on each output page is specified. Up to 72 characters can be specified (card columns 8 to 80).

<u>DAMP</u>

When DAMP control card is input longitudinal dynamic derivatives are computed and the results output for the configuration. Dynamic derivatives for configuration components or partial configurations may be output using the PART or BUILD control cards respectively.

<u>DELETE name1,name2</u>

This control card instructs the program to ignore a previous case namelist input that was retained using the SAVE control card. All previously saved namelists with the names specified will be purged from the input file.

Any new inputs of the same namelist will be retained. At least one name (name1) must be specified.

DIM IN, DIM FT, DIM CM, or DIM M

This control card sets the system of units for the user inputs and program outputs. The four options are inches (DIM IN), feet (DIM FT), centimeters (DIM CM), and meters (DIM M). The default system of units is feet. Once the system of units has been set, it remains set for all subsequent cases of the "run".

DERIV DEG or DERIV RAD

All output derivatives are set to either degree (DERIV DEG) or radian (DERIV RAD) measure. The default setting is degree. The derivative units can be changed more than once during the run by inputting multiple DERIV cards.

DUMP CASE

Internal data blocks, used in the computation of the case, are written on Tape 6. This control card automatically selects partial output (PART).

DUMP name1,name2

This permits the user to write selected internal data blocks or common blocks on Tape 6. At least one name (name1) must be specified. The arrays will be dumped in units of feet, pounds, degrees or degrees Rankine. Table 5 shows the common block dump names and Tables 8 through 62 provide a definition of each common block.

FORMAT (format)

This control card is used in conjunction with the WRITE control card. It specifies the format of the data to be printed to tape unit 3. The format is input starting with a left parenthesis, the format and a right parenthesis. This is exactly the same as a FORTRAN FORMAT statement. Because of the code structure, alphanumeric data must not be printed. For example:

FORMAT ((8(2X,F10.4))	is legal
FORMAT (2HX=,F10.4)	is illegal

The default format is 8F10.4, and will be used if the FORMAT control card is not present. Multiple formats can be used. The last FORMAT read will be used for all successive WRITE statements until another FORMAT is encountered. Hence, the FORMAT must precede the applicable WRITE.

HYPER

This control card causes the program to select the Newtonian flow method for bodies at any Mach number above 1.4. HYPER should normally be selected at Mach numbers greater than 6.

INCRMT

This card is used to set the configuration incrementing flag. Configuration incrementing uses the first case of a run to determine correction factors for the longitudinal and lateral aerodynamic coefficients. These correction factors are computed by comparing theoretical and experimental values for each coefficient for which data is input. The experimental values are input using namelist EXPR. During subsequent cases of the run, the correction factors are applied to coefficients for which experimental data was input in the first case. This provides the user with a method to evaluate changes in a configuration.

The INCRMT card must be input in the first case of a run. The first case must be run at the same Mach number as the experimental data which is input. Once the increment flag is set it cannot be deleted during that run.

The following restrictions apply:

- All cases of a run must have the same number of fin sets.
- All cases of a run must have the same sideslip or aerodynamic roll angle as the first case (BETA or PHI as specified in namelist FLTCON).
- The first case must be run at exactly the same angles of attack as the experimental data being input.
- All cases must be run within the same Mach regime (subsonic, transonic, or supersonic) as the experimental data.
- Experimental data can only be input in the first case and only for the complete configuration. No additional data can be substituted.
- To increment $C_{Y\beta}$ and $C_{N\alpha}$ experimental data must be input for C_Y and C_N.

Use of configuration incrementing may or may not increase the accuracy of the results. The following guidelines will produce better results when using configuration incrementing:

- The user may run different angles of attack in each case. However, no angle of attack should exceed the upper or lower limit of the angles of attack for which experimental data was input in the first case.

- Experimental data should be input at as many angles of attack as possible.

- The user should remember that the effect of a change in Mach number from case to case is not corrected by inputting experimental data at one Mach number as is required.

NACA

This card defines the NACA airfoil section designation (or supersonic airfoil definition). Note that if airfoil coordinates and the NACA card are specified for the same aerodynamic surface, the airfoil coordinate specification will be used. Therefore, if coordinates have been specified in a previous case and the SAVE option is in effect, the saved namelist must be deleted or the namelist variable SECTYP must be changed for the NACA card to be recognized for that aerodynamic surface. The airfoil designated with this card will be used for all segments and panels of the fin set.

The form of this control card and the required parameters are as follows:

Card Column(s)	Input(s)	Purpose
1 thru 4	NACA	The unique letters NACA designate that an airfoil is to be defined
5	Any delimiter	
6	1,2,3, or 4	Fin set number for which the airfoil designation applies
7	Any delimiter	
8	1,4,5,6,S	Type of NACA airfoil section; 1-series (1), 4-digit (4), 5-digit (5), 6-series (6), or supersonic (S)
9	Any delimiter	
10 thru 80	Designation	Input designation (see Table 6); columns are free-field (blanks are ignored)

Only fifteen (15) characters are accepted in the airfoil designation. The vocabulary consists of the following characters:

0 1 2 3 4 5 6 7 8 9 A , = . -

Any characters input that are not in the vocabulary list will be interpreted as the number zero (0). Table 6 details the restrictions on the NACA designation.

NAMELIST

This control card instructs the program to print all namelist data. This is useful when multiple inputs of the same variable or namelist are used.

NEXT CASE

This card indicates termination of the case input data and instructs the program to begin case execution. It is required for multiple case "runs". This card must be the last card input for the case.

NOGO

This control card permits the program to cycle through all of the input cases without computing configuration aerodynamics. It can be present anywhere in the input stream and only needs to appear once. This option is useful for performing error checking to insure all cases have been correctly set up.

NO LAT

This control card inhibits the calculation of the lateral-directional derivatives due to sideslip angle. Savings in computation time can be realized by using this option. This option is automatically selected when using TRIM.

PART

This control card permits printing of partial aerodynamic output, such as a summary of the normal force and axial force contributors. Partial output of the configuration synthesis methods is only provided if the TRIM option is not selected. Use of this card is equivalent to inputing all PRINT AERO and PRINT GEOM control cards.

PLOT

A data file for use with a post-processing plotting program is provided when this control card is used. A formatted file is written to unit 3. Appendix B shows the format of this data file.

PRESSURES

This control card instructs the program to print the body and fin alone pressure coefficient distributions at supersonic speeds. Only pressure data to 15 degrees angle of attack for bodies and at zero angle of attack for fins are printed.

PRINT AERO name

This control card instructs the program to print the incremental aerodynamics for "name", which can be one of the following:

BODY	for body aerodynamics
FIN1	for FINSET1 aerodynamics
FIN2	for FINSET2 aerodynamics
FIN3	for FINSET3 aerodynamics
FIN4	for FINSET4 aerodynamics
SYNTHS	for configuration synthesis aerodynamics
TRIM	for trim/untrimmed aerodynamics
BEND	for panel bending moments
HINGE	for panel hinge moments
INLET	for inlet aerodynamics

All options are automatically selected when the control card PART is used. Details of the output obtained with these options are presented in Section 4.2.

PRINT EXTRAP

This control card enables the printing of method extrapolation messages produced during execution of the case. Extrapolation messages are not normally provided.

PRINT GEOM name

This control card instructs the program to print the geometric characteristics of the configuration component "name", which can be one of the following:

BODY	for body geometry
FIN1	for FINSET1 geometry
FIN2	for FINSET2 geometry
FIN3	for FINSET3 geometry
FIN4	for FINSET4 geometry
INLET	for inlet geometry

If PRINT GEOM BODY is selected and the Mach number is greater than 1.2, the body contour coordinates (X,R) used by the program are written to tape unit 3. This contour will contain many additional points in between the user specified input coordinates.

All options are automatically selected when the control card PART is used.

SAVE

The SAVE card saves namelist inputs from one case to the following case but not for the entire run. This permits the user to build-up or change a complex configuration, case-to-case, by adding new namelist cards without having to re-input namelist cards of the previous case. When changing a namelist that has been saved, the namelist must first be deleted using the delete control card.

The only control card that can be optionally saved, case-to-case, is the NACA card.

SOSE

The presence of this control card selects the Second-Order Shock Expansion Method for axisymmetric bodies at supersonic speeds. SOSE should be selected if any Mach number is higher than 2.0.

SPIN

When the SPIN control card is input, spin and magnus derivatives are computed for body alone. If the configuration being run is a body + fin sets, the spin derivatives are still computed for body alone. A PART or BUILD card must be input for body alone derivatives to be printed out.

TRIM

This control card causes the program to perform a trim calculation. Component buildup data cannot be dumped if TRIM is selected. The use of this control card is the same as if the namelist TRIM was included except that the defaults for namelist TRIM are used.

WRITE name, start, end

This control card causes the common block "name" to be printed to tape unit 3 using the most recent FORMAT control card. Locations from "start" to "end" are dumped (see Table 5 for common block write names). A complete definition of each common block is provided in Tables 8 through 62. Multiple WRITE statements may be input, and there is no limit to the number which may be present. The presence of a WRITE will cause the block "name" to be printed for all cases of the run. The output will be in units of feet, pounds, degrees, or degrees Rankine. If the PLOT option is also selected, this output will be "mixed" with the PLOT file output on tape unit 3.

*

Any card with an asterisk (*) in Column 1 will be interpreted as a comment card. This permits detailed documentation of case inputs.

3.3 TYPICAL CASE SET-UP

Figure 19 schematically shows how Missile Datcom inputs are structured. This example illustrates a multiple case job in which case 2 uses part of the case 1 inputs. This is accomplished through use of the SAVE control card. Case 1 is a body-wing-tail configuration; partial output, component buildup data, and a plot file are created. Case 2 uses the body and tail data of case 1 (the wing is deleted using DELETE), specifies panel deflection angles and sets the data required to trim.

There is no limit to the number of cases that can be "stacked" in a single run, provided that no more than 300 namelist inputs are "saved" between cases. If a SAVE control card is not present in a case, all previous case inputs are deleted.

3.3.1 Configuration Incrementing Case Set-up

A "configuration incrementing" case set-up is shown in Figure 20. This figure shows the inputs for a three case set-up fin parametric analysis. The first case is the calibration case with the remaining cases being used for the parametric analysis. Therefore, the first case must contain both the INCRMT control card and EXPR namelist. These should only appear in the first case.

3.4 SPECIAL USAGE OF INPUT PARAMETERS

It is possible to manipulate the input geometry, such that unique configurations can be modeled. This section defines those capabilities.

3.4.1 Locating Panels on Varying Body Radii Segments

The fin panels can be located anywhere on the geometry. If they are to be positioned on a varying radii segment, select the root chord span station [SSPAN(1)] such that the center of the exposed root chord is on the surface mold line. Physically this places part of the panel within the body and part offset from the body.

If SSPAN(1) is input precisely as zero, the code will assume that panel semi-span stations relative to the root chord are defined. It will then interpolate the body geometry at the root chord center and add the body radius at this point to the user defined values in the SSPAN array.

Table 1 Body Addressable Configurations

CONFIGURATION	SUBSONIC $M \leq 0.6$	TRANSONIC $0.6 < M \leq 1.2$	SUPERSONIC $M > 1.2$
1. Nose Shape			
Conical			
Sharp	x	x	x
Blunted	x	x	x
Truncated	x	x	x
Tangent Ogive			
Sharp	x	x	x
Blunted	x	x	x
Truncated	x	x	x
Other		x	x
2. Centerbody Shape			
Cylinder	x	x	x
Elliptically Variable	x	x	x
3. Afterbody Shape			
Boattails			
Conical	x	x	x
Tangent Ogive	x	x	x
Other			x
Flares			
Conical	x	x	x
Ogive			x
Other			x

Table 2 Subsonic/Transonic Method Limitations

METHOD	RANGE PERMITTED	ACTION TAKEN IF EXCEEDED
Nose Bluntness (C_N, C_m)	Sharp Only	Uses Sharp Method
Conical Nose Slope	0 to 25 Degrees	Uses 25 Degrees
Boattail Shape	Cone or Ogive	Uses Cone
Conical Boattail Slope	0 to 16 Degrees	Extrapolates
Ogive Boattail Slope	0 to 28 Degrees	Extrapolates
Flare Shape	Cone	Uses Cone
Flare Slope	0 to 10 Degrees	Extrapolates
Airfoil t/c	0 to 12%	Continues, If Possible

Table 3 Namelist Alphanumeric Constants

NAMELIST	PERMITTED ALPHANUMERIC CONSTANTS	CONVERTED VALUE
(ALL)	UNUSED	1.0E-30 (Initialized Value)
REFQ	TURB	0.
	NATURAL	1.
AXIBOD or ELLBOD	CONICAL	0.
	CONE	0.
	OGIVE	1.
	POWER	2.
	HAACK	3.
	KARMAN	4.
PROTUB	VCYL	1.
	HCYL	2.
	BLOCK	5.
	FAIRING	6.
	LUG	3.
	SHOE	4.
FINSETn	HEX	0.
	NACA	1.
	ARC	2.
	USER	3.
INLET	AXI	3.
	2DTOP	1.
	2DSIDE	2.
EXPR	BODY	1.
	F1	2.
	F2	3.
	F3	4.
	F4	5.
	BF1	6.
	BF12	7.
	BF123	8.
	BF1234	9.

Table 4 Equivalent Sand Roughness

TYPE OF SURFACE	EQUIVALENT SAND ROUGHNESS k (INCHES)	RHR
Aerodynamically Smooth	0.0	0.0
Polished Metal or Wood	0.02 E-3 to 0.08 E-3	6 to 26
Natural Sheet Metal	0.16 E-3	53
Smooth Matte Paint, Carefully Applied	0.25 E-3	83
Standard Camouflage Paint, Average Application	0.40 E-3	133
Camouflage Paint, Mass-Production Spray	1.20 E-3	400
Dip Galvanized Metal Surface	6.0 E-3	2000
Natural Surface of Cast Iron	10.0 E-3	3333

PREFERRED RHR VALUES

APPLICATION	RHR
Steel Structural Parts	250
Aluminum and Titanium Structural Parts	125
Close Tolerance Surfaces	63
Seals	32

NAMELIST FLTCON

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
NALPHA	-	NUMBER OF ANGLES OF ATTACK (AT LEAST 2)	-	-
ALPHA	20	ANGLE OF ATTACK OR TOTAL ANGLE OF ATTACK	DEG	-
BETA	-	SIDESLIP ANGLE	DEG	0.
PHI	-	AERODYNAMIC ROLL ANGLE	DEG	0.
NMACH	-	NUMBER OF MACH NUMBERS (AT LEAST 1)	-	-
MACH ①	20	MACH NUMBERS	-	-
REN ①	20	REYNOLDS NUMBER PER UNIT LENGTH	1/L ②	-
ALT ①	-	GEOMETRIC ALTITUDE	L ③	0.
VINF ①	20	FREESTREAM SPEED	L/SEC ④	-
TINF ①	20	FREESTREAM STATIC TEMPERATURE	DEG	-
PINF ①	20	FREESTREAM STATIC PRESSURE	F/(L*L) ⑤	-

① THE FOLLOWING COMBINATIONS SATISFY THE REYNOLDS NUMBER AND MACH NUMBER INPUT REQUIREMENTS

USER INPUT	PROGRAM COMPUTES
1. MACH, REN	(NONE)
2. MACH, ALT	PINF, TINF, REN
3. VINF, ALT	PINF, TINF, MACH, REN
4. VINF, TINF, PINF	MACH, REN
5. MACH, TINF, PINF	VINF, REN

② INPUT AS 1/FT FOR ENGLISH UNITS AND 1/M FOR METRIC UNITS
③ INPUT AS FT FOR ENGLISH UNITS AND M FOR METRIC UNITS
④ INPUT AS FT/SEC FOR ENGLISH UNITS AND M/SEC FOR METRIC UNITS
⑤ INPUT AS LB/FT^2 FOR ENGLISH UNITS AND N/M^2 FOR METRIC UNITS

Figure 1 Flight Conditions Inputs

NAMELIST REFQ

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
SREF	-	REFERENCE AREA	L*L	②
LREF	-	REFERENCE LENGTH (LONGITUDINAL)	L	③
LATREF	-	REFERENCE LENGTH (LATERAL-DIRECTIONAL)	L	LREF
ROUGH ①	-	SURFACE ROUGHNESS HEIGHT	L ④	0.
RHR ①	-	ROUGHNESS HEIGHT RATING	-	0.
XCG	-	LONGITUDINAL POSITION OF C.G. (+AFT)	L	0.
ZCG	-	VERTICAL POSITION OF C.G. (+UP)	L	0.
SCALE	-	VEHICLE SCALE FACTOR (MULTIPLIER TO GEOMETRY)	-	1.
BLAYER	-	BOUNDARY LAYER TYPE: **TURB** FOR FULLY TURBULENT, **NATURAL** FOR NATURAL TRANSITION	-	TURB

① EITHER CAN BE USED
② DEFAULT IS BODY MAXIMUM CROSS-SECTIONAL AREA. IF NO BODY IS INPUT, MAXIMUM FIN PANEL AREA IS USED.
③ DEFAULT IS BODY MAXIMUM DIAMETER. IF NO BODY IS INPUT, MAXIMUM FIN PANEL MEAN GEOMETRIC CHORD IS USED.
④ INPUT AS INCHES FOR ENGLISH UNITS AND CENTIMETERS FOR METRIC UNITS.

Figure 2 Reference Quantity Inputs

NAMELIST AXIBOD

OPTION 1 INPUTS

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
XO OR X0	-	LONGITUDINAL COORDINATE AT NOSE TIP	L	0.
TNOSE	-	NOSE SHAPE NAME: **CONICAL**, **CONE**, **OGIVE**, **POWER**, **HAACK**, OR **KARMAN**	-	OGIVE
POWER	-	EXPONENT, n, FOR POWER SERIES SHAPES, $(r/R) = (x/L)^n$	-	0.
LNOSE	-	NOSE LENGTH	L	-
DNOSE	-	NOSE SECTION BASE DIAMETER	L	1.0
BNOSE	-	NOSE BLUNTNESS RADIUS OR TRUNCATED NOSE RADIUS	L	0.
TRUNC	-	TRUNCATION FLAG (.TRUE. IF NOSE IS TRUNCATED)	-	.FALSE.
LCENTR	-	CENTERBODY LENGTH	L	0.
DCENTR	-	CENTERBODY BASE DIAMETER	L	DNOSE
TAFT ①	-	AFTERBODY SHAPE NAME: **CONICAL**, **CONE**, OR **OGIVE**	-	CONICAL
LAFT ①	-	AFTERBODY LENGTH	L	0.
DAFT ④ ①	-	AFTERBODY BASE DIAMETER	L	-
DEXIT	-	DIAMETER OF NOZZLE EXIT	L	-
BASE ②	-	BASE-JET PLUME INTERACTION FLAG (.TRUE. IF CALCULATIONS DESIRED)	-	.FALSE.
BETAN ②	-	NOZZLE EXIT ANGLE	DEG	-
JMACH ② ③	20	JET MACH NUMBER AT NOZZLE EXIT	-	-
PRAT ② ③	20	JET TO FREESTREAM STATIC PRESSURE RATIO	-	-
TRAT ② ③	20	JET TO FREESTREAM STAGNATION TEMPERATURE RATIO	-	-

① AFT BODY MUST NOT BE CYLINDRICAL (i.e. **DAFT** NOT EQUAL TO **DCENTR**)

② ONLY REQUIRED IF BASE-JET PLUME INTERACTION CALCULATIONS DESIRED. (**DEXIT** MUST NOT EQUAL ZERO)

③ **JMACH**, **PRAT**, AND **TRAT** ARE SPECIFIED FOR EACH FREESTREAM MACH NUMBER OR VELOCITY INPUT IN NAMELIST $FLTCON

④ DAFT MUST BE NON-ZERO

Figure 3a Axisymmetric Body Geometry Inputs - Option 1

NAMELIST AXIBOD

OPTION 2 INPUTS (USE ONLY IF MACH > 1.2)

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
XO OR X0	-	LONGITUDINAL COORDINATE AT NOSE TIP	L	0.
BNOSE	-	NOSE BLUNTNESS RADIUS OR TRUNCATED NOSE RADIUS	L	0.
TRUNC	-	TRUNCATION FLAG (.TRUE. IF NOSE IS TRUNCATED)	-	.FALSE.
DEXIT	-	DIAMETER OF NOZZLE EXIT	L	-
NX	-	NUMBER OF INPUT STATIONS	-	-
X ①	50	LONGITUDINAL COORDINATES	L	-
R	50	RADIUS AT EACH X STATION	L	-
DISCON	20	INDICES OF X STATIONS WHERE THE SURFACE SLOPE IS DISCONTINUOUS	-	-

① X(NX) MUST BE END OF BODY

Figure 3b Axisymmetric Body Geometry Inputs - Option 2

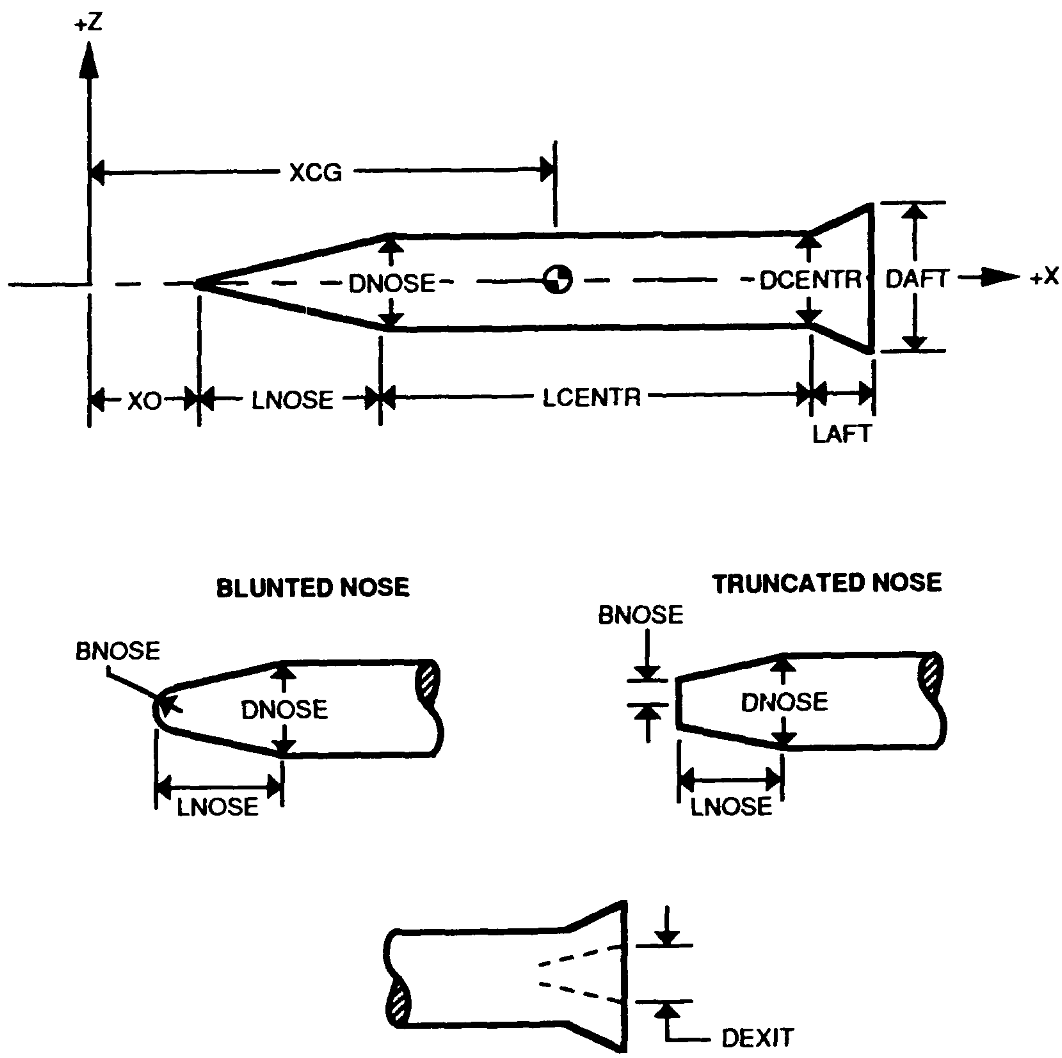
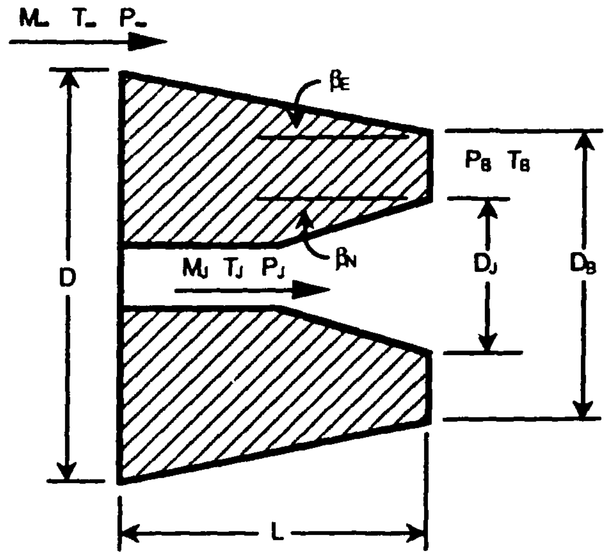


Figure 4 Body Geometry Inputs



Input Parameter	Symbol	Min. Value	Max. Value
Boattail shape	--	Cylinder, Cone, Ogive	
Boattail fineness ratio	L/D	0	2
Boattail terminal angle	β_E	0°	12°
Jet pressure ratio	P_J/P_∞	0	10
Freestream Mach number	M_∞	2	5
Angle of Attack	α	0°	8°
Jet Mach number	M_J	M_∞ -1	M_∞+1
Nozzle terminal angle	β_N	5°	25°
Jet diameter ratio	D_J/D_B	0.80	0.95
Jet temperature ratio	$T_{tj}/T_{t\infty}$	4	10

Note; If input parameter is not between minimum and maximum value the code will extrapolate

Figure 5 Base-Jet Plume Interaction Parameters

NAMELIST ELLBOD
OPTION 1 INPUTS

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
XO OR X0	-	LONGITUDINAL COORDINATE AT NOSE TIP	L	0.
TNOSE	-	NOSE SHAPE NAME: **CONICAL**, **CONE**, **OGIVE**, **POWER**, **HAACK**, OR **KARMAN**	-	OGIVE
POWER	-	EXPONENT, n, FOR POWER SERIES SHAPES, $(r/R) = (x/L)^n$	-	0.
LNOSE	-	NOSE LENGTH	L	-
WNOSE	-	NOSE SECTION BASE WIDTH	L	1.0
BNOSE	-	NOSE BLUNTNESS RADIUS OR TRUNCATED NOSE RADIUS	L	0.
TRUNC	-	TRUNCATION FLAG (.TRUE. IF NOSE IS TRUNCATED)	-	.FALSE.
ENOSE	-	ELLIPTICITY AT NOSE BASE (H/W)	-	1.0
LCENTR	-	CENTERBODY LENGTH	L	0.
WCENTR	-	CENTERBODY BASE WIDTH	L	WNOSE
ECENTR	-	ELLIPTICITY AT CENTERBODY BASE (H/W)	-	1.0
TAFT ①	-	AFTERBODY SHAPE NAME: **CONICAL**, **CONE**, OR **OGIVE**	-	CONICAL
LAFT ①	-	AFTERBODY LENGTH	L	0.
WAFT ①	-	AFTERBODY BASE WIDTH	L	-
EAFT ①	-	ELLIPTICITY AT AFT BODY BASE (H/W)	-	1.0
DEXIT	-	DIAMETER OF NOZZLE EXIT	L	-

① AFT BODY MUST NOT BE CYLINDRICAL (i.e. **WAFT** NOT EQUAL TO **WCENTR**)

Figure 6a Elliptical Body Geometry Inputs - Option 1

NAMELIST ELLBOD

OPTION 2 INPUTS (USE ONLY IF MACH > 1.2)

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
XO OR X0	-	LONGITUDINAL COORDINATE AT NOSE TIP	L	0.
BNOSE	-	NOSE BLUNTNESS RADIUS OR TRUNCATED NOSE RADIUS	L	0.
TRUNC	-	TRUNCATION FLAG (.TRUE. IF NOSE IS TRUNCATED)	-	.FALSE.
DEXIT	-	DIAMETER OF NOZZLE EXIT	L	-
NX	-	NUMBER OF INPUT STATIONS	-	-
X ①	50	LONGITUDINAL COORDINATES	L	-
W ②	50	BODY HALF-WIDTH AT EACH X STATION	L	-
DISCON	20	INDICES OF X STATIONS WHERE THE SURFACE SLOPE IS DISCONTINUOUS	-	-
H ②	50	BODY HALF-HEIGHT AT EACH X STATION	L	-
ELLIP ②	50	BODY HEIGHT TO WIDTH RATIO AT EACH X STATION	-	1.0

① X(NX) MUST BE END OF BODY
② ONE OF THE FOLLOWING COMBINATIONS IS REQUIRED: W AND H, W AND ELLIP, OR H AND ELLIP

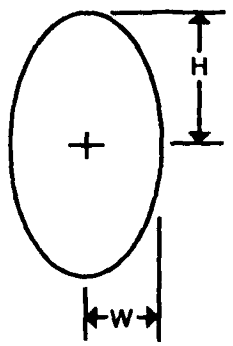


Figure 6b Elliptical Body Geometry Inputs - Option 2

NAMELIST PROTUB

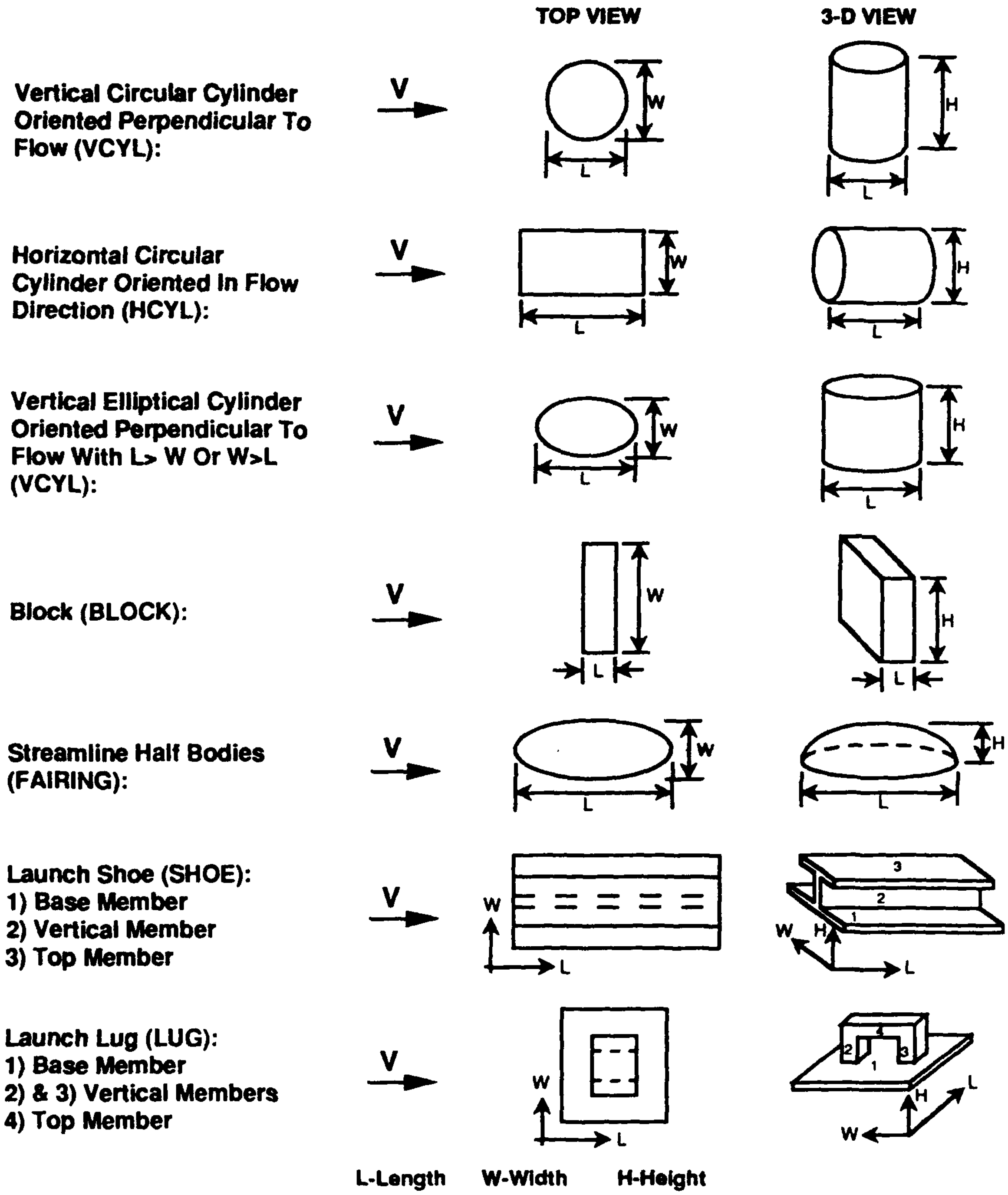
VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
NPROT	-	NUMBER OF PROTUBERANCE SETS (20 MAXIMUM)	-	0.
PTYPE	20	PROTUBERANCE SET TYPE: **VCYL**, **HCYL**, **BLOCK**, **FAIRING**, **LUG**, OR **SHOE** ②	-	-
XPROT	20	LONGITUDINAL DISTANCE FROM MISSILE NOSE TO PROTUBERANCE SET	L	-
NLOC ①	20	NUMBER OF PROTUBERANCES IN EACH PROTUBERANCE SET	-	0.
LPROT ③	100	LENGTH OF EACH MEMBER OR PROTUBERANCE	L	-
WPROT ③	100	WIDTH OF EACH MEMBER OR PROTUBERANCE	L	-
HPROT ③	100	HEIGHT OF EACH MEMBER OR PROTUBERANCE	L	-
OPROT ③	100	VERTICAL OFFSET OF EACH MEMBER OR PROTUBERANCE	L	0.

① **NLOC** ACCOUNTS FOR IDENTICAL PROTUBERANCES (SAME SIZE AND SHAPE) LOCATED AROUND THE BODY AT THE SAME AXIAL LOCATION.

② **LUG** TYPE HAS 4 MEMBERS. **SHOE** TYPE HAS 3 MEMBERS. **LPROT**, **WPROT**, **HPROT**, AND **OPROT** MUST BE SPECIFIED FOR EACH MEMBER.

③ INPUT FOR EACH PROTUBERANCE (**VCYL**, **HCYL**, **BLOCK**, OR **FAIRING** TYPE) OR EACH PROTUBERANCE MEMBER (**LUG** AND **SHOE** TYPE)

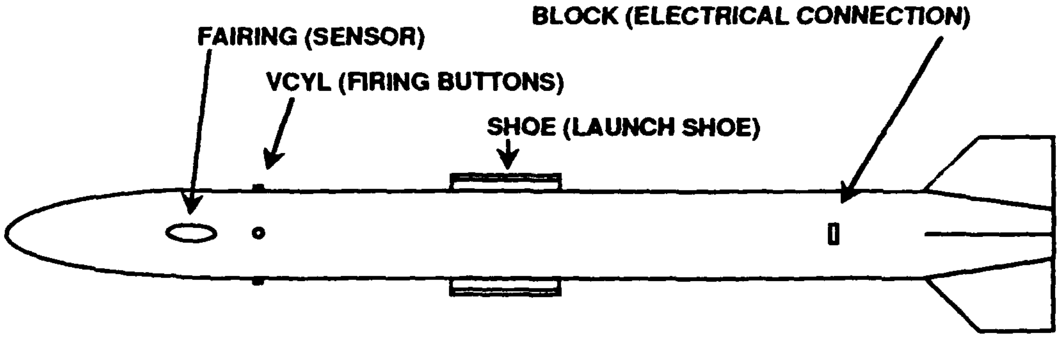
Figure 7 Protuberance Inputs



Note; Length, width, height, and offset must be input for each member of launch lug and launch shoe types

Note; Offset is the perpendicular distance from the missile mold line to the bottom of the protuberance or protuberance member

Figure 8 Protuberance Shapes Available




```
CASEID PROTUBERANCE EXAMPLE CASE
DIM IN
NO LAT
 $REFQ    XCG=39.0,$
 $FLTCON NMACH=3.,MACH=0.4,0.8,2.0,
         REN=3.E06,3.E06,3.E06,ALT=0.0,
         NALPHA=5.,ALPHA=-8.,-4.,0.,4.,8.,$
 $AXIBOD TNOSE=OGIVE,LNOSE=12.0,DNOSE=12.0,
         LCENTR=54.0,DCENTR=12.0,
         TAFT=CONE,LAFT=12.0,DAFT=6.0,DEXIT=5.0,$
 $PROTUB NPROT=4.,
         PTYPE=FAIRING,VCYL,SHOE,BLOCK,
         XPROT=14.,22.,39.,56.,
         NLOC=2.,4.,2.,1.,
         LPROT=5.,1.,10.,10.,10.,0.5,
         WPROT=2.,1.,4.,0.25,1.,1.,
         HPROT=2.,0.5,0.1,0.75,0.25,0.25,
         OPROT=0.,0.,0.,0.1,0.85,0.,$
 $FINSET1 SSPAN=0.0,9.0,CHORD=14.0,8.0,
          XLE=64.0,SWEEP=0.0,STA=1.0,NPANEL=4.,
          PHIF=45.,135.,225.,315.,$
PRINT GEOM BODY
PRINT AERO BODY
SAVE
NEXT CASE
```

NOTE; Length, Width, and Height is input for each member of the launch shoe

Figure 9 Protuberance Example Input File

NAMELIST FINSETn
NOMINAL INPUTS

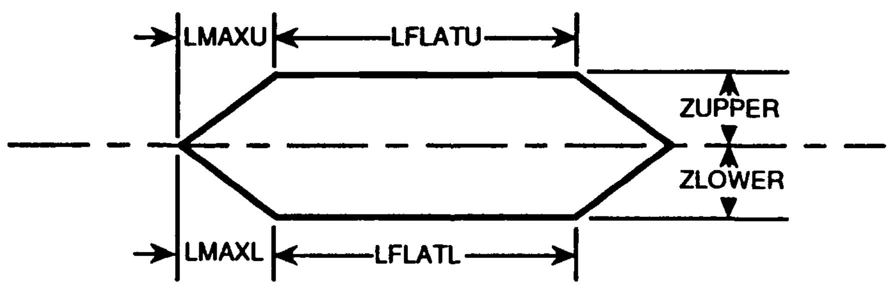
VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
SECTYP	-	TYPE OF SECTION TO BE DEFINED: HEX, NACA, ARC, OR USER	-	HEX
SSPAN ①	10	SEMI-SPAN	L	-
CHORD	10	PANEL CHORD LENGTH AT EACH SSPAN	L	-
XLE	10	DISTANCE FROM NOSE TIP TO CHORD LEADING EDGE AT EACH SSPAN	L	0.0
SWEEP ②	10	SWEEPBACK ANGLE AT EACH SSPAN	DEG	0.0
STA	10	CHORD STATION USED IN MEASURING SWEEP AT EACH SSPAN (0.0=LEADING EDGE, 1.0=TRAILING EDGE)	-	1.0
LER ③	10	PANEL LEADING EDGE RADIUS AT EACH SPAN STATION	L	0.0
NPANEL	-	NUMBER OF PANELS IN SET (1-8)	-	4
PHIF	8	ROLL ANGLE OF EACH FIN MEASURED CLOCKWISE FROM TOP VERTICAL CENTER LOOKING FORWARD	DEG	④
GAM	8	DIHEDRAL OF EACH FIN (POSITIVE WHEN PHIF IS INCREASED, SEE FIG. 12)	DEG	0.0
SKEW	-	ANGLE BETWEEN THE Y AXIS AND THE FIN HINGE LINE (POSITIVE SWEPT BACK)	DEG	0.0
CFOC	10	FLAP CHORD TO FIN CHORD RATIO	-	1.0

① IF SSPAN(1)=0.0, INPUTS ARE RELATIVE TO ROOT CHORD NOT BODY CENTERLINE
② IF USING SWEEP, SPECIFY ONLY XLE(1); IF USING XLE DO NOT SPECIFY SWEEP
③ NOT REQUIRED FOR NACA AIRFOILS, REQUIRED FOR USER AIRFOILS
④ IF PHIF NOT INPUT THE NUMBER OF PANELS ARE EVENLY SPACED ABOUT THE BODY.

Figure 10a Fin Geometry Inputs - Nominal

NAMELIST FINSETn
OPTIONAL INPUTS

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
ZUPPER	10	MAXIMUM THICKNESS TO CHORD RATIO OF UPPER SURFACE	-	0.025
ZLOWER	10	MAXIMUM THICKNESS TO CHORD RATIO OF LOWER SURFACE	-	ZUPPER
LMAXU	10	FRACTION OF CHORD FROM SECTION LEADING EDGE TO MAXIMUM THICKNESS OF UPPER SURFACE	-	0.5
LMAXL	10	FRACTION OF CHORD FROM SECTION LEADING EDGE TO MAXIMUM THICKNESS OF LOWER SURFACE	-	LMAXU
LFLATU	10	FRACTION OF CHORD OF CONSTANT THICKNESS SECTION ON UPPER SURFACE	-	0.0
LFLATL	10	FRACTION OF CHORD OF CONSTANT THICKNESS SECTION ON LOWER SURFACE	-	LFLATU



NOTE; THESE PARAMETERS MUST BE INPUT AT EACH SPAN STATION

Figure 10b Fin Geometry Inputs - Optional

NAMELIST FINSETn

INPUTS FOR "USER" SECTIONS

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
XCORD	50	CHORD STATION, FRACTION OF CHORD FROM LEADING EDGE	-	-
MEAN ①	50	DISTANCE BETWEEN THE MEAN LINE AND CHORD LINE AT EACH XCORD, FRACTION OF CHORD	-	-
THICK ①	50	THICKNESS TO CHORD RATIO AT EACH XCORD	-	-
YUPPER ① ②	50	UPPER SURFACE COORDINATES, FRACTION OF CHORD, AT EACH XCORD	-	-
YLOWER ① ②	50	LOWER SURFACE COORDINATES, FRACTION OF CHORD, AT EACH XCORD	-	-

NOTE; ALL VARIABLES ARE EXPRESSED AS FRACTIONS OF CHORD
LEADING EDGE RADIUS (VARIABLE LER) MUST BE DEFINED

① EITHER MEAN AND THICK OR YUPPER AND YLOWER ARE REQUIRED
② THE AIRFOIL SECTION MUST BE CLOSED. THIS MEANS THE FINAL CHORD STATION INPUT MUST HAVE EITHER THICK=0.0 OR YUPPER=YLOWER.

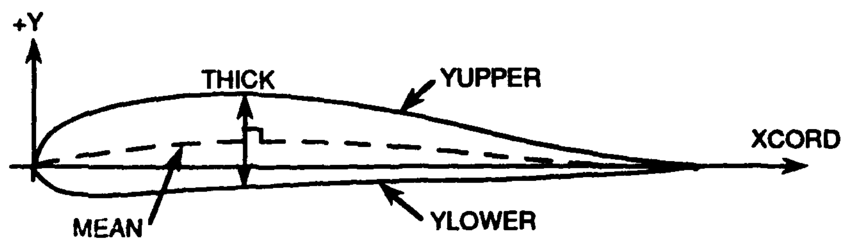
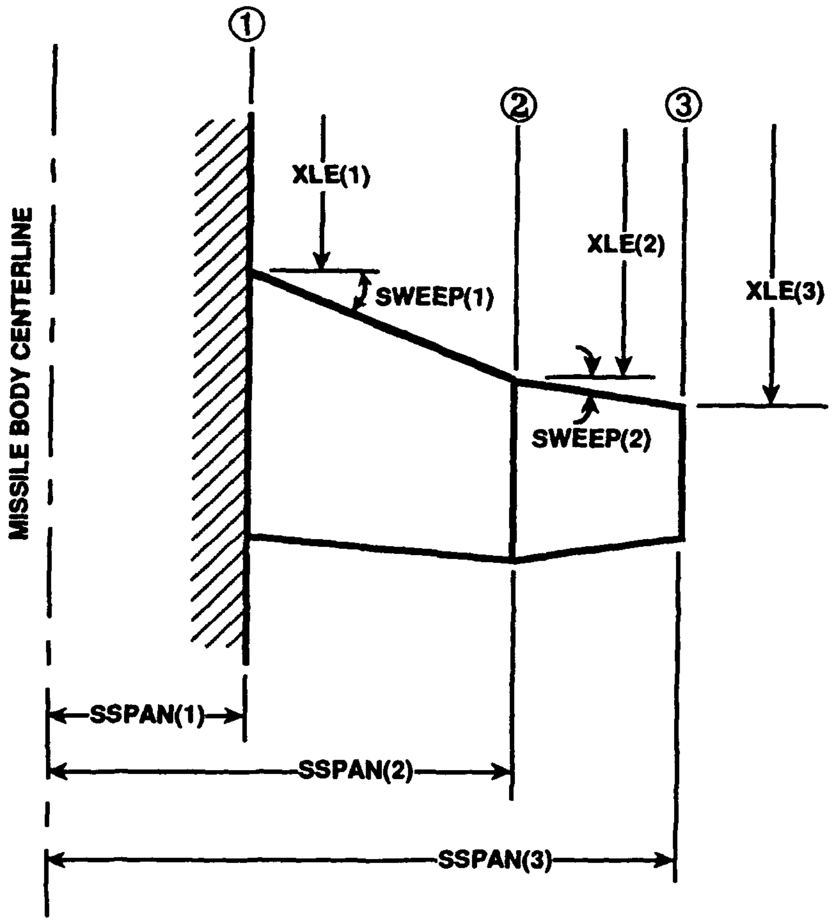


Figure 10c Fin Geometry Inputs - User Airfoils



NOTE; XLE IS MEASURED FROM NOSE TIP

IF SSPAN(1) IS INPUT AS ZERO, SSPAN INPUTS ARE RELATIVE TO BODY SURFACE MOLD LINE

Figure 11a Selecting Panel Break Points

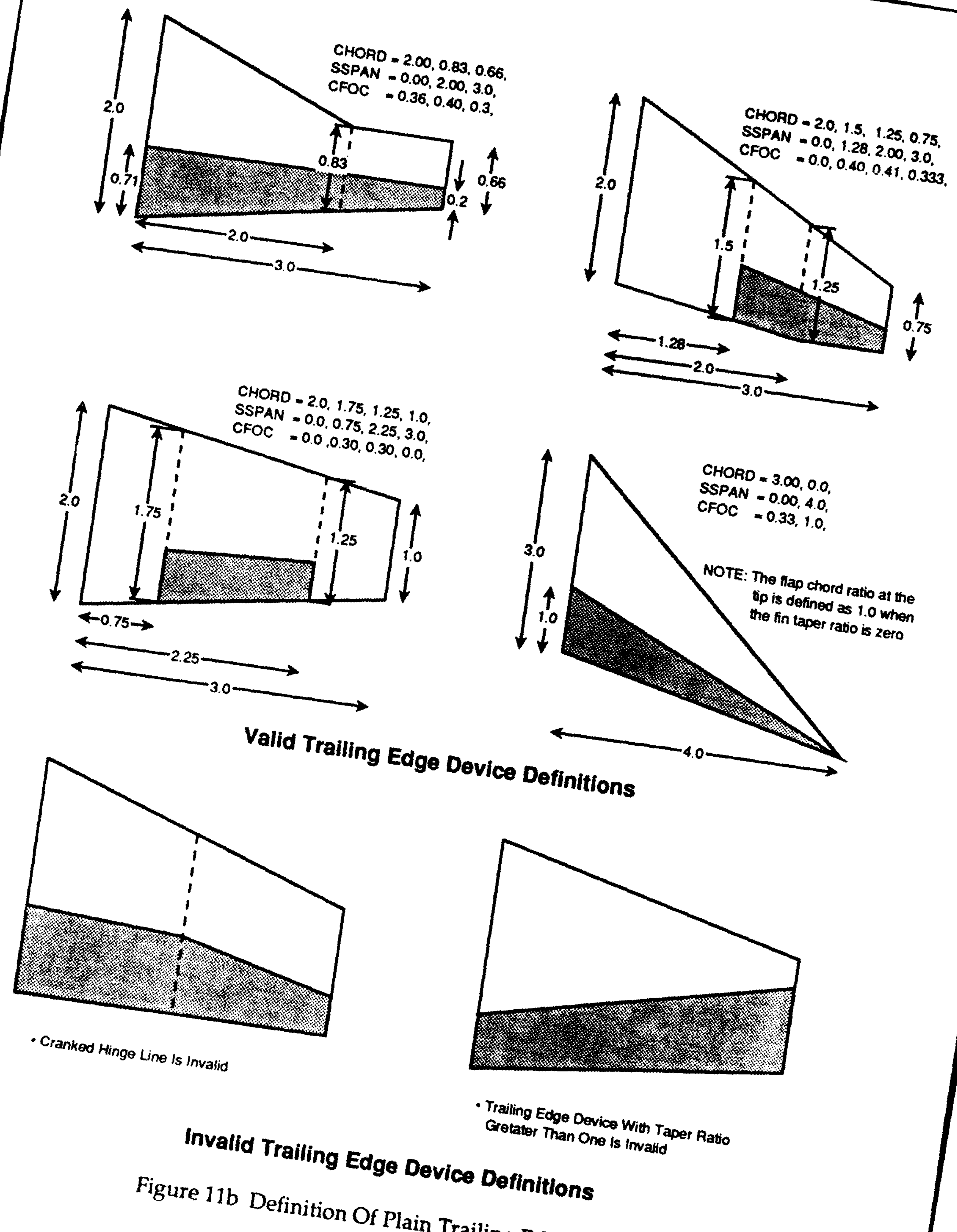


Figure 11b Definition Of Plain Trailing Edge Devices

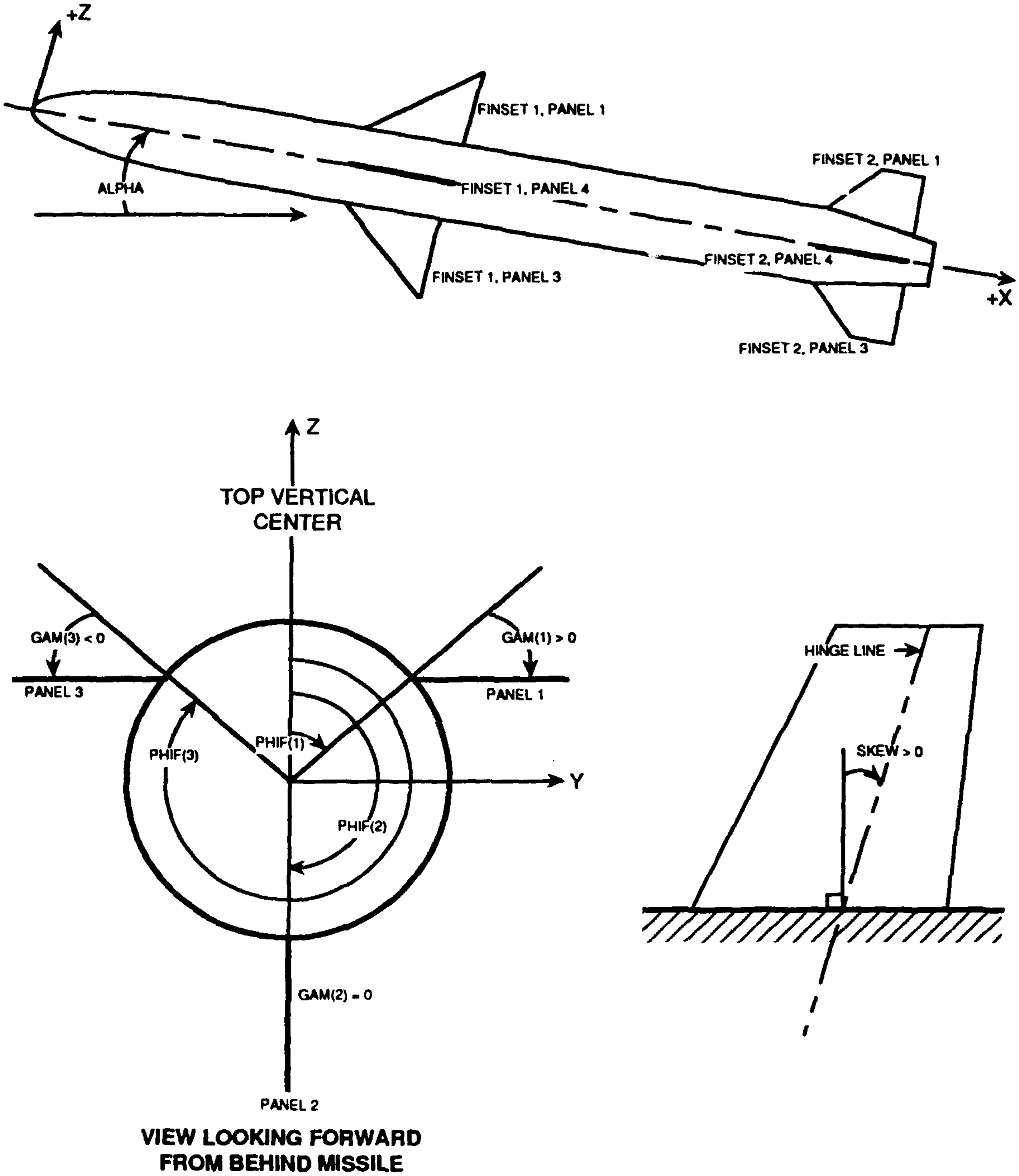
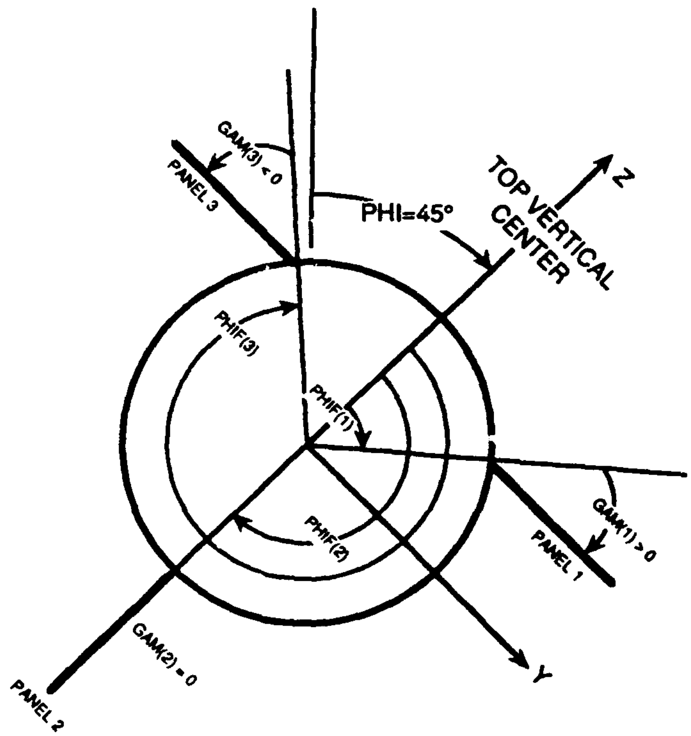


Figure 12 Fin Numbering and Orientation



VIEW LOOKING FORWARD FROM BEHIND MISSILE

PHI IS THE BODY ROLL ANGLE
PHIF IS THE FIN PANEL ROLL ANGLE

Figure 13 Roll Attitude vs Fin Orientation

NAMELIST DEFLCT

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
DELTA1 ①	8	DEFLECTION ANGLES FOR EACH PANEL IN FIN SET 1 (SUBSCRIPT IS FIN NUMBER)	DEG	0.
DELTA2 ①	8	DEFLECTION ANGLES FOR EACH PANEL IN FIN SET 2 (SUBSCRIPT IS FIN NUMBER)	DEG	0.
DELTA3 ①	8	DEFLECTION ANGLES FOR EACH PANEL IN FIN SET 3 (SUBSCRIPT IS FIN NUMBER)	DEG	0.
DELTA4 ①	8	DEFLECTION ANGLES FOR EACH PANEL IN FIN SET 4 (SUBSCRIPT IS FIN NUMBER)	DEG	0.
XHINGE	4	DISTANCE FROM COORDINANT SYSTEM ORIGIN TO PANEL HINGE LINE FOR EACH FIN SET	L	XO+XLE +CR/2 ②
SKEW	4	SWEEPBACK OF HINGE LINE FOR EACH FIN SET	DEG	0.

① PANEL NUMBERING IS SHOWN IN FIGURE 12
② DEFAULT IS AT ONE-HALF THE EXPOSED ROOT CHORD, AS MEASURED FROM THE COORDINANT SYSTEM ORIGIN.

NOTE; A POSITIVE DEFLECTION ANGLE PRODUCES A NEGATIVE BODY AXIS ROLLING MOMENT AT ZERO ANGLE OF ATTACK

Figure 14 Panel Deflection Inputs

NAMELIST TRIM

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
SET	-	FIN SET TO BE USED FOR TRIM	-	1.
PANL1 ①	-	.TRUE. IF PANEL TO BE USED	-	.FALSE.
PANL2 ①	-	.TRUE. IF PANEL TO BE USED	-	.FALSE.
PANL3 ①	-	.TRUE. IF PANEL TO BE USED	-	.FALSE.
PANL4 ①	-	.TRUE. IF PANEL TO BE USED	-	.FALSE.
PANL5 ①	-	.TRUE. IF PANEL TO BE USED	-	.FALSE.
PANL6 ①	-	.TRUE. IF PANEL TO BE USED	-	.FALSE.
PANL7 ①	-	.TRUE. IF PANEL TO BE USED	-	.FALSE.
PANL8 ①	-	.TRUE. IF PANEL TO BE USED	-	.FALSE.
DELMIN ②	-	MINIMUM NEGATIVE DEFLECTION	DEG	-25.
DELMAX ②	-	MAXIMUM POSITIVE DEFLECTION	DEG	+20.
ASYM	8	.TRUE. IF PANEL WITH SUBSCRIPT IS TO BE DEFLECTED OPPOSITE TO NORMAL SIGN CONVENTION (ASYMMETRIC DEFLECTIONS)	-	.FALSE.

① DEFAULTS APPLY ONLY IF ALL PANL# DATA ARE NOT INPUT OR .FALSE.
② BOTH DELMIN AND DELMAX MUST BE SPECIFIED

Figure 15 Trim Inputs

NAMELIST INLET

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
NIN	-	NUMBER OF INLETS (MAXIMUM=20)	-	-
INTYPE	-	TYPE OF INLET: **2DTOP**, **2DSIDE**, OR **AXI** ①	-	-
XINLT	-	LONGITUDINAL DISTANCE FROM NOSE TIP TO INLET LEADING EDGE	L	-
XDIV	-	LONGITUDINAL DISTANCE FROM INLET LEADING EDGE TO DIVERTER LEADING EDGE	L	-
HDIV	-	HEIGHT OF DIVERTER LEADING EDGE	L	-
LDIV	-	LENGTH OF DIVERTER	L	-
PHI ②	20	INLET ROLL ORIENTATIONS	DEG	-
X ③	5	INLET LONGITUDINAL POSITIONS RELATIVE TO INLET LEADING EDGE	L	-
H ④ ③	5	INLET HEIGHTS AT THE LONGITUDINAL POSITIONS	L	-
W ⑤ ③	5	INLET WIDTHS AT THE LONGITUDINAL POSITIONS	L	-
COVER	-	IF COVER=.TRUE. INLETS ARE COVERED	-	.FALSE.
RAMP	-	EXTERNAL COMPRESSION RAMP ANGLE	DEG	-
ADD	-	IF ADD=.TRUE. INLET ADDITIVE DRAG IS CALCULATED	-	.FALSE.
MFR ⑥	20	MASS FLOW RATIO FOR EACH MACH NUMBER ($0 \leq$ MFR ≤ 1.0)	-	-

① **2DTOP**: TWO DIMENSIONAL TOP MOUNTED, **2DSIDE**: TWO DIMENSIONAL SIDE MOUNTED, **AXI**: AXISYMMETRIC

② ROLL POSITIONS FROM TOP VERTICAL CENTER. SAME CONVENTION AS FIN ROLL POSITIONS.

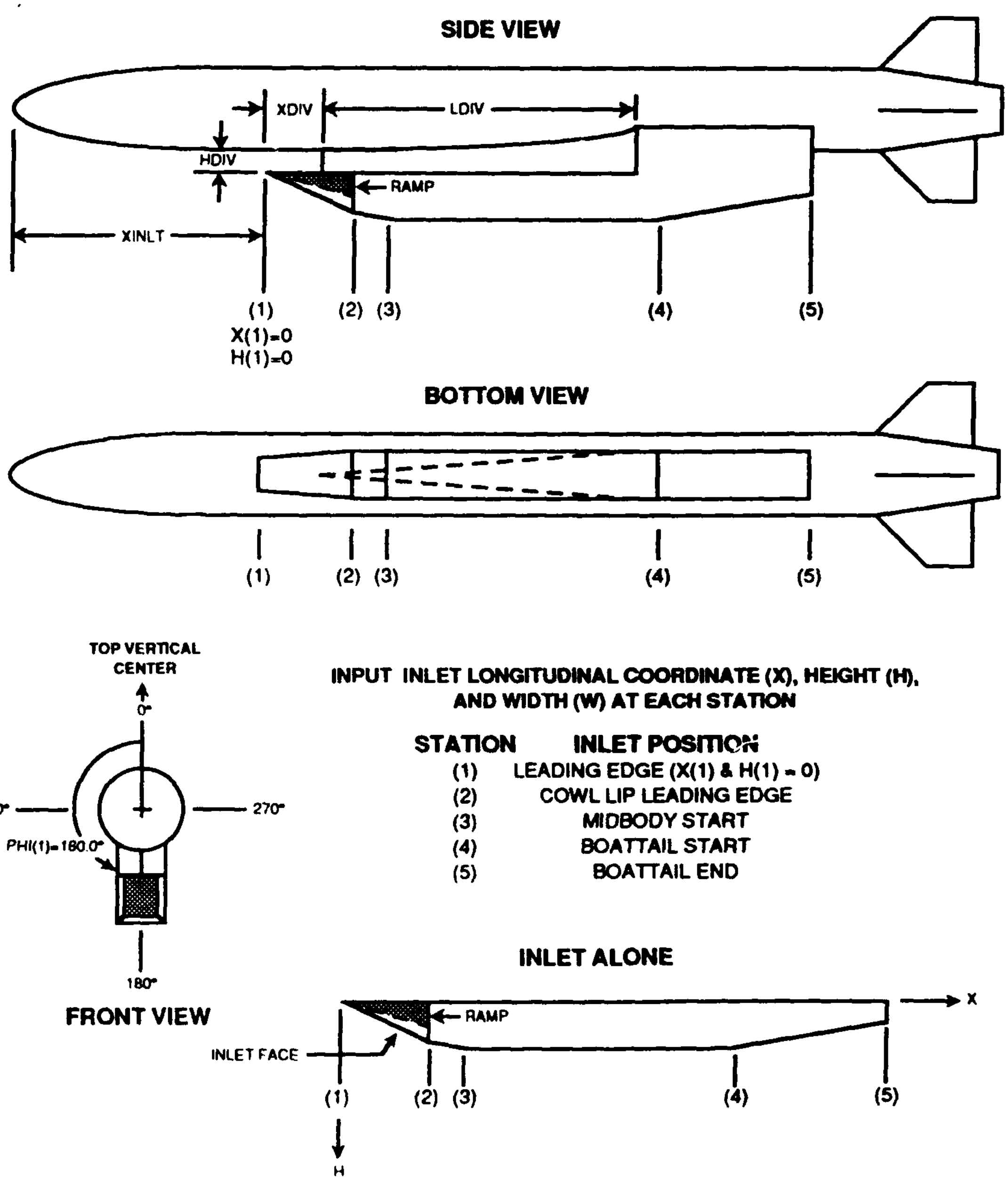
③ SPECIFY **X**, **H**, AND **W** AT FIVE INLET LOCATIONS: 1) LEADING EDGE, 2) COWL LIP LEADING EDGE, 3) MIDBODY START, 4) START OF BOATTAIL, 5) END OF BOATTAIL

④ NOT REQUIRED IF INTYPE=**AXI**

⑤ IF INTYPE=**AXI**, W=DIAMETER

⑥ SPECIFY MASS FLOW RATIO, **MFR**, FOR EACH FREE STREAM MACH NUMBER OR VELOCITY GIVEN IN $FLTCON (ONLY REQUIRED IF **ADD** = .TRUE.)

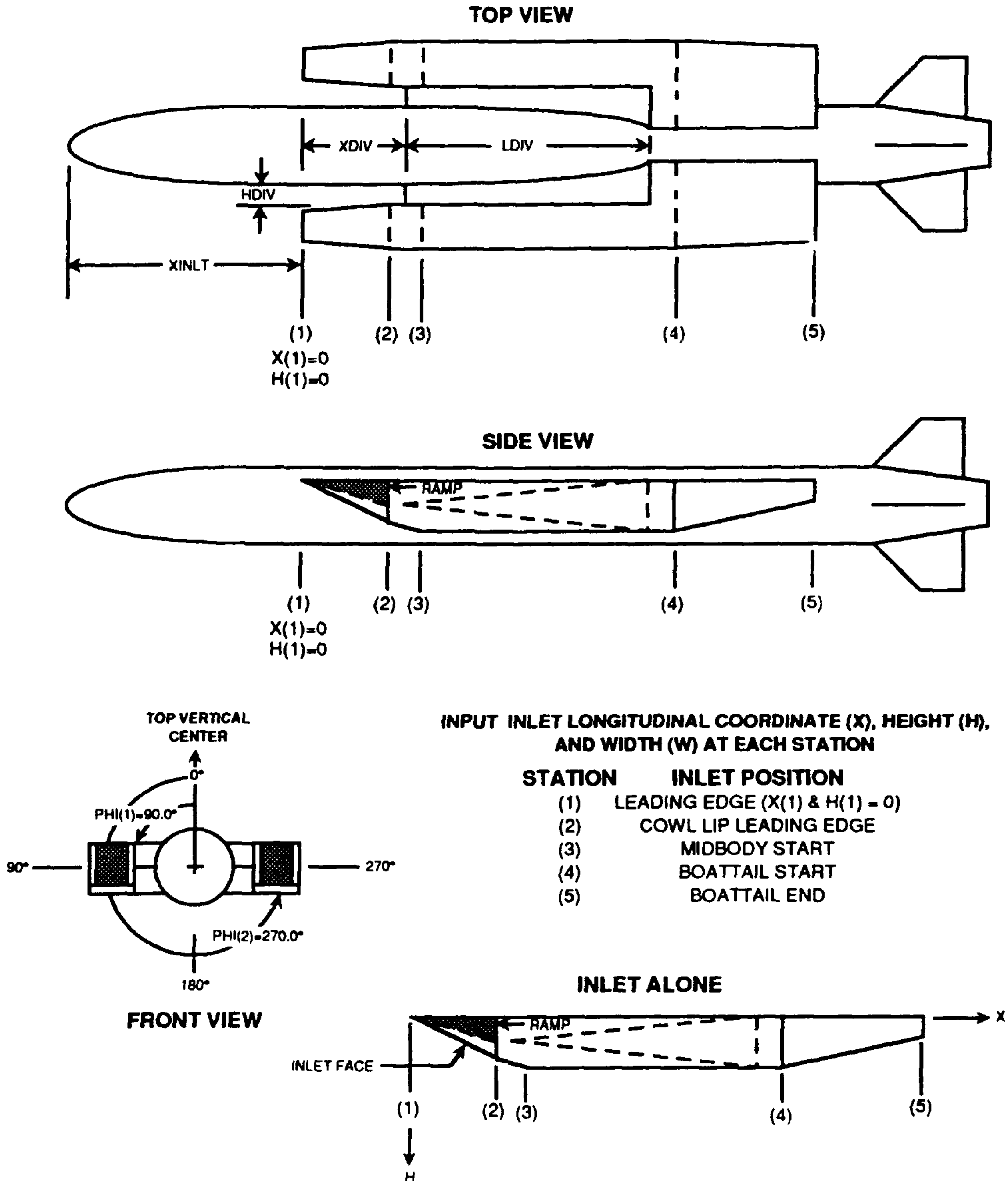
Figure 16 Inlet Geometry Inputs



NOTES;

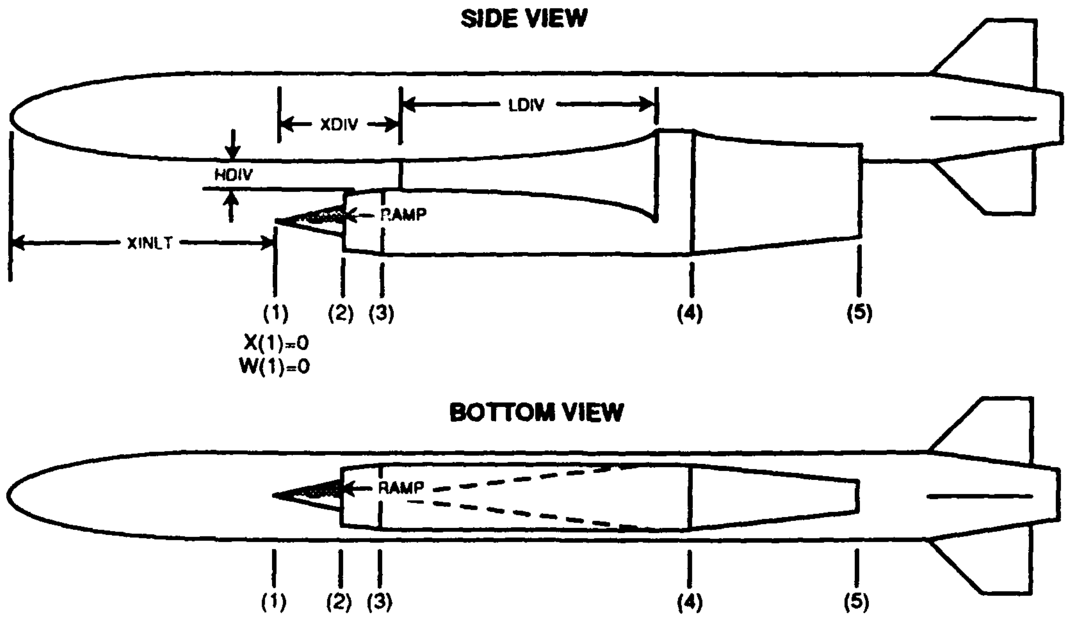
- INLET ROLL ORIENTATION IS SAME CONVENTION AS FIN ROLL ORIENTATION.
- RAMP IS THE EXTERNAL COMPRESSION RAMP ANGLE (SHOWN SHADED IN THE SIDE VIEW)
- HEIGHT OF THE DIVERTER IS SPECIFIED AT THE DIVERTER LEADING EDGE
- THE DIVERTER WIDTH IS EQUAL TO THE INLET WIDTH AT LDIV
- IF INLET IS COVERED (COVER=.TRUE.) A PLUG IS PLACED BETWEEN STATIONS 1 AND 2 FLUSH WITH THE INLET FACE

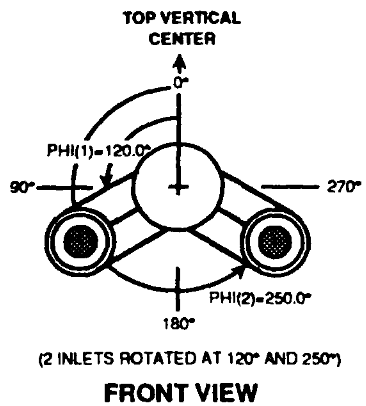
Figure 17a Top-Mounted 2-D Inlet/Diverter Geometry



NOTES;
- INLET ROLL ORIENTATION IS SAME CONVENTION AS FIN ROLL ORIENTATION.
- RAMP IS THE EXTERNAL COMPRESSION RAMP ANGLE (SHOWN SHADED IN THE SIDE VIEW)
- HEIGHT OF THE DIVERTER IS SPECIFIED AT THE DIVERTER LEADING EDGE
- THE DIVERTER WIDTH IS EQUAL TO THE INLET WIDTH AT LDIV
- IF INLET IS COVERED (COVER=.TRUE.) A PLUG IS PLACED BETWEEN STATIONS 1 AND 2 FLUSH WITH THE INLET FACE

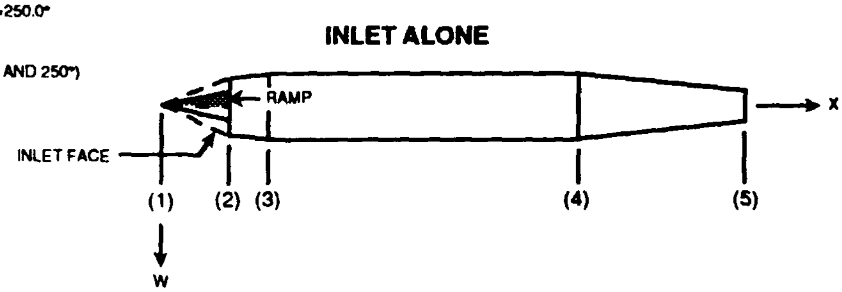
Figure 17b Side-Mounted 2-D Inlet/Diverter Geometry





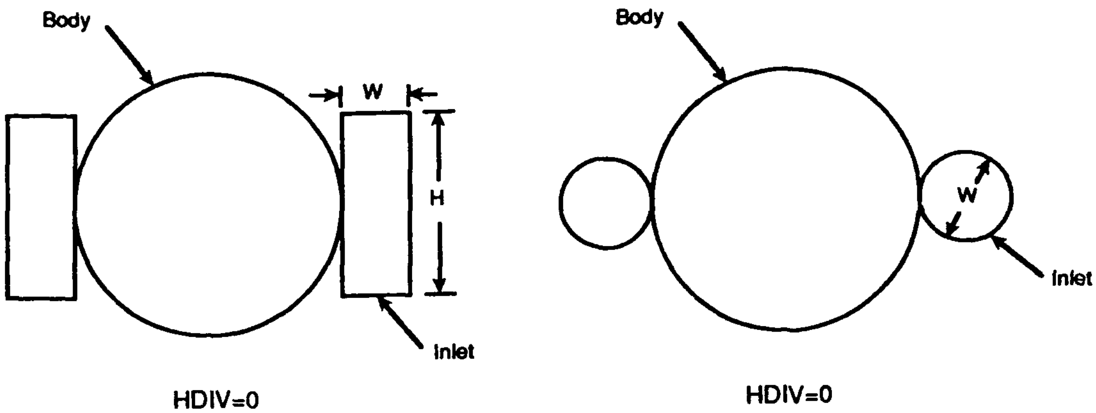
INPUT INLET LONGITUDINAL COORDINATE (X), AND DIAMETER (W) AT EACH STATION

STATION	INLET POSITION
(1)	TIP (X(1) & W(1) = 0)
(2)	COWL LIP LEADING EDGE
(3)	MIDBODY START
(4)	BOATTAIL START
(5)	BOATTAIL END

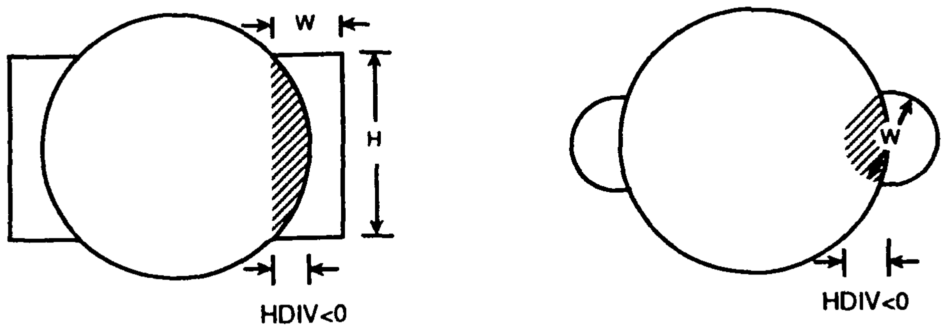


NOTES;
- INLET ROLL ORIENTATION IS SAME CONVENTION AS FIN ROLL ORIENTATION.
- RAMP IS THE EXTERNAL COMPRESSION CONE HALF-ANGLE (SHOWN SHADED IN THE SIDE VIEW)
- HEIGHT OF THE DIVERTER IS SPECIFIED AT THE DIVERTER LEADING EDGE
- THE DIVERTER WIDTH IS EQUAL TO THE INLET DIAMETER AT LDIV
- IF INLET IS COVERED (COVER=.TRUE.) A PLUG IS PLACED BETWEEN STATIONS 1 AND 2 FLUSH WITH THE INLET FACE

Figure 17c Axisymmetric Inlet/Diverter Geometry



Conformal Inlets



Semi-Submerged Inlets

Figure 17d Geometry Definition For Conformal And Semi-Submerged Inlets

NAMELIST EXPR

VARIABLE NAME	ARRAY DIMENSION	DEFINITION	UNITS	DEFAULT
MACH	-	MACH NUMBER	-	-
NALPHA	-	NUMBER OF ANGLES OF ATTACK (2-20)	-	-
ALPHA	20	ANGLES OF ATTACK FOR DATA	DEG	-
SREF	-	REFERENCE AREA FOR DATA	L*L	①
LREF	-	LONGITUDINAL REFERENCE LENGTH FOR DATA	L	②
LATREF	-	LATERAL REFERENCE LENGTH FOR DATA	L	LREF
XCG	-	LONGITUDINAL C.G. FOR DATA	L	0.
ZCG	-	VERTICAL C.G. FOR DATA	L	0.
CONF	-	CONFIGURATION FOR DATA SELECT ONE OF THE FOLLOWING BODY - BODY F1 - WING F2 - TAIL F3 - THIRD FIN SET F4 - FOURTH FIN SET BF1 - BODY-WING BF12 - BODY-2 FIN SETS BF123 - BODY-3 FIN SETS BF1234 - BODY-4 FIN SETS	-	-
CN	20	C_N DATA VS ALPHA	-	-
CM	20	C_M DATA VS ALPHA	-	-
CA	20	C_A DATA VS ALPHA	-	-
CY	20	C_Y DATA VS ALPHA	-	-
CSN	20	C_n DATA VS ALPHA	-	-
CSL	20	C_l DATA VS ALPHA	-	-

① DEFAULT IS BODY MAXIMUM CROSS-SECTIONAL AREA. IF NO BODY IS INPUT, MAXIMUM FIN PANEL AREA IS USED.

② DEFAULT IS BODY MAXIMUM DIAMETER. IF NO BODY IS INPUT, MAXIMUM FIN PANEL MEAN GEOMETRIC CHORD IS USED.

Figure 18 Experimental Data Inputs

Table 5 Common Block DUMP and WRITE Names

COMMON BLOCK	DUMP NAME	WRITE NAME
ABODIN	BDIN	ABODIN or EBODIN
BDWORK	BDWK	BDWORK
CASEID		CASEID
CONST		CONST
DBODY	DBOD	DBODY
DB1	DB1	DB1
DB12	DB12	DB12
DB123	DB13	DB123
DB1234	DB14	DB1234
DESIG		DESIG
DDFIN1	DF1	DFIN1
DDFIN2	DF2	DFIN2
DDFIN3	DF3	DFIN3
DDFIN4	DF4	DFIN4
DFLAGS		DFLAGS
DUMPF		DUMPF
FLC	FLT	FLC
FSET1	F1IN	FSET1
FSET2	F2IN	FSET2
FSET3	F3IN	FSET3
FSET4	F4IN	FSET4
F1WORK	F1WK	F1WORK
F2WORK	F2WK	F2WORK
F3WORK	F3WK	F3WORK
F4WORK	F4WK	F4WORK
GEOBOD	GEOB	GEOBOD
GEOFS1	F1GM	GEOFS1
GEOFS2	F2GM	GEOFS2
GEOFS3	F3GM	GEOFS3
GEOFS4	F4GM	GEOFS4
INCID		INCID
INLETN	INLI	INLETN
INLTD	INLD	INLTD
INPCON		INPCON
LOGIC		LOGIC
PAERO		PAERO
REFQN	REFQ	REFQN
SBODY	SBOD	SBODY
SB1	SB1	SB1
SB12	SB12	SB12
SB123	SB13	SB123
SB1234	SB14	SB1234
SFIN1	SF1	SFIN1
SFIN2	SF2	SFIN2
SFIN3	SF3	SFIN3
SFIN4	SF4	SFIN4
THERY		THERY
TOTALC	FLCT	TOTALC
TRACE		TRACE
TRIMD		TRIMD
TRIMIN		TRIMIN
UTRIMD		UTRIMD

Table 6 Airfoil Designation Using the NACA Control Card

INPUT NACA DESIGNATION	NACA SERIES AIRFOIL	RESTRICTIONS
0012.25	4-Digit	None. Fractional thickness may be specified.
23118.50	5-Digit	None. Fractional thickness may be specified.
2406-32	4-Digit modified	Sixth digit specifies position of maximum thickness, (%chord/10), and must be a 2, 3, 4, 5, or 6.
43006-65	5-Digit modified	Seventh digit specifies position of maximum thickness, (%chord/10), and must be a 2, 3, 4, 5, or 6.
16-212.25	1-Series	Second digit specifies location of minimum pressure, (%chord/10), and must be a 6, 8, or 9. Fractional thickness may be specified.
64-005 64-205 A=0.6 63A005 652A215 A=0.8 65,2A215 A=0.8	6-Series	Second digit specifies location of minimum pressure, (%chord/10), and must be a 3, 4, 5, or 6. The mean line parameter (A=xx) must be a decimal between 0.1 and 1.0 (Default is1.0). See Note 1.
3-30.0-2.5-40.1 A B C D	Supersonic	See Note 2. A - Section type: 1=Double Wedge 2=Circular Arc 3=Hexagonal B - Distance from leading edge to position of maximum thickness, % of chord. C - Maximum thickness, % of chord. D - For hexagonal sections, length of surface of constant thickness, % of chord.

Note 1. The program does not distinguish between a 64,2-220 and a 64-220 specification. The difference in coordinates between the two is negligible.

Note 2. All parameters can be expressed to 0.1%. The delimiter "-" must be used.

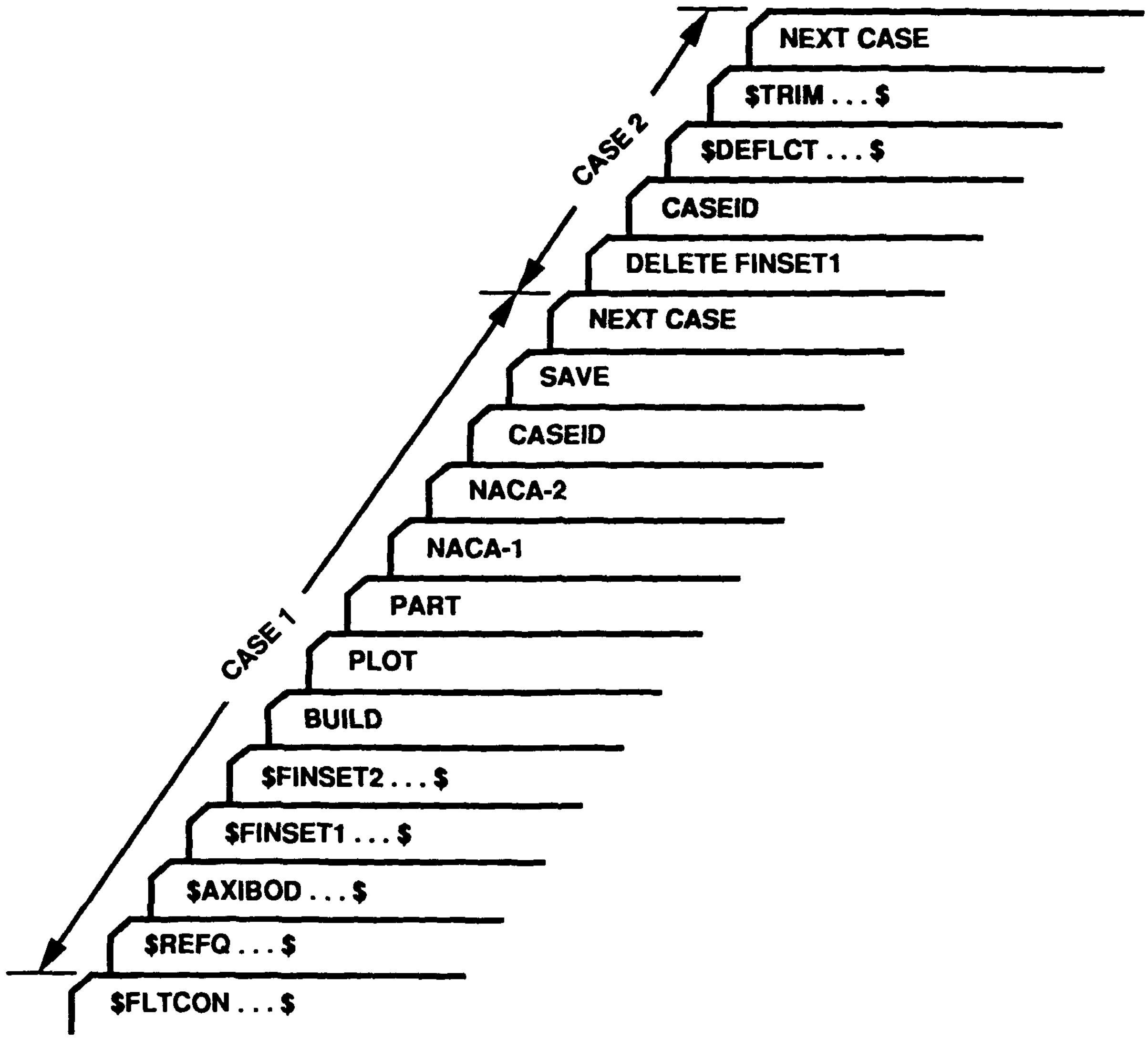


Figure 19 Typical "Stacked" Case Set-up

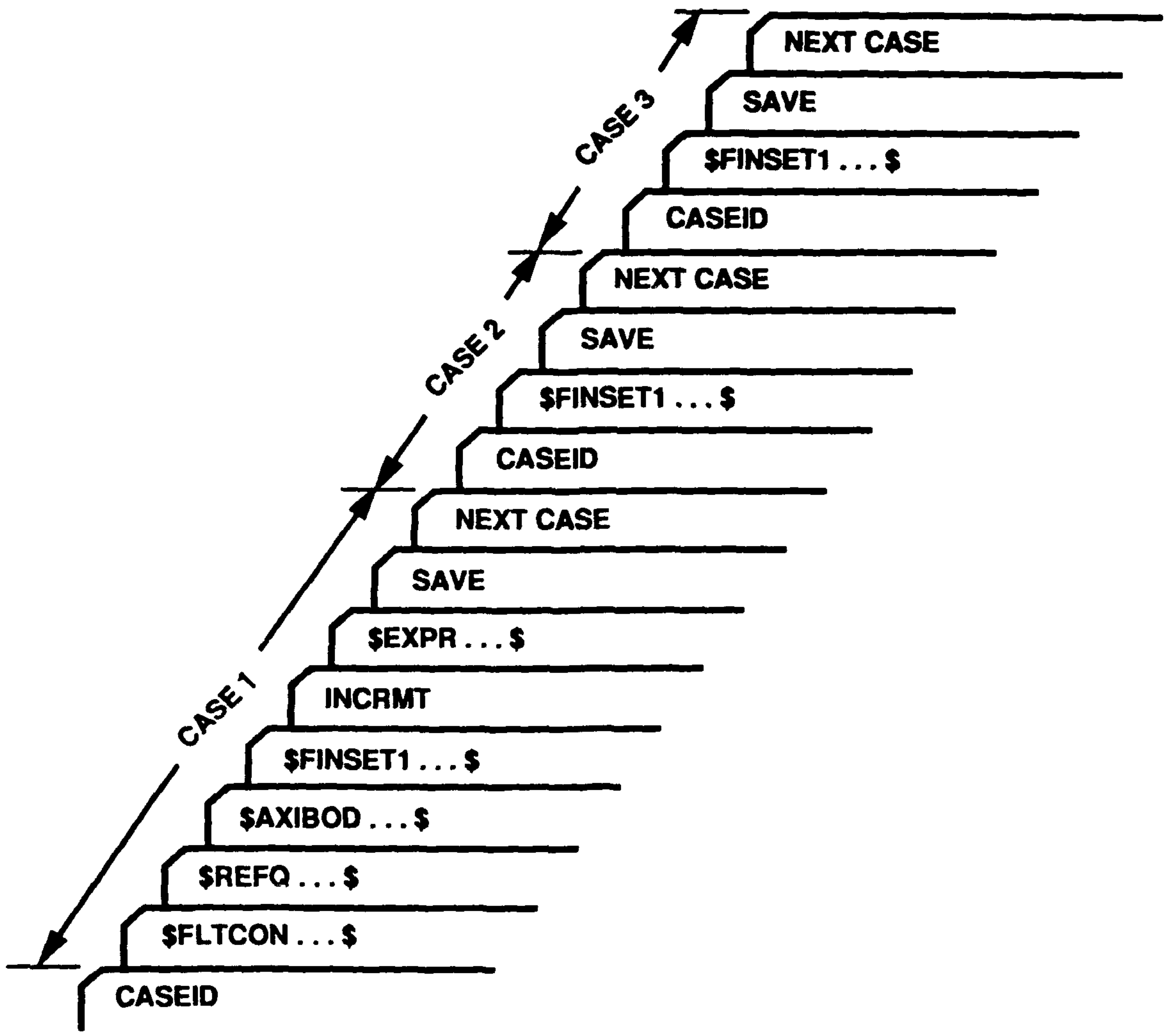


Figure 20 "Configuration Incrementing" Case Set-up

4.0 OUTPUT DESCRIPTION

This section describes the types of output available from the code. In most cases the available output is user selectable, that is, it is not normally provided and must be specifically requested using a specialized control card. This feature permits the user to tailor the code output to fit his particular application without extensive reprogramming. This allows him to find the output that he is interested in without having to wade through output that does not interest him.

The following four types of output are available from the code:

- Nominal output - This output is always provided by the code and consists of output from the input error checking module (CONERR), a listing of the inputs for each case, and the final aerodynamic results for the configuration.

- Partial output - This output details the configuration geometry and the intermediate aerodynamic calculations. Special control cards are available so that the user can select the quantity and types of output desired.

- External data files - This output permits the user to create external data files which can be used in post-processing programs, such as plotting or trajectory programs. Both fixed and user defined format data files can be created with the addition of simple control cards.

- Array dumps and extrapolation messages - This output permits the user to print internal data arrays (DUMP) or to investigate design chart extrapolations during the course of the case execution (PRINT EXTRAP).

The remainder of the section describes each of these output data. Examples of each output page are also included and were created from the example problems, described in Appendix A, which can be used as a model for setting up another, similar configuration or be used as a means to check the proper operation of the code.

4.1 NOMINAL OUTPUT

Without the use of any program options the code will provide three types of output. First, an analysis by the input error checking routine is provided. It lists all input cards provided by the user and identifies any input errors detected. Second, a listing of all input cards, grouped by case, are provided; included in this output is an error analysis from the major input error routine MAJERR. Finally, the total configuration aerodynamics are provided in summary form; one page of aerodynamic output is supplied for each Mach number specified. The MAJERR results and the total configuration aerodynamics results are listed in succession for each case.

4.1.1 Input Error Checking

The purpose of the input error checking module is to provide single pass error checking of all inputs. If an error is detected, it is identified and an appropriate error message provided. The error messages are designed to be self-explanatory. In some cases, errors are automatically corrected by the routine, although the routine was not designed to be a comprehensive error correction utility.

The following errors are automatically corrected by the code:

- No terminating comma on a namelist input card
- No terminating "$" or "$END" on a namelist input ("&" on IBM systems)
- No terminating NEXT CASE for the case inputs for single case or last case inputs.

Errors detected by the error checking routine are considered either "FATAL" or "NON-FATAL". A "FATAL" error is one which will cause the code to terminate execution abnormally; examples of "FATAL" errors include incorrect spelling of any namelist name, incorrect spelling of any variable name, and any drastic input error in a namelist input, such as leaving out an equals sign in a constant definition. All "FATAL" errors are clearly identified on the output. A "NON-FATAL" error is one which will not cause the program to terminate execution; an example of a "NON-FATAL" error is leaving off the decimal point on numeric constants all Missile Datcom inputs are either REAL or LOGICAL regardless of the variable name assigned. "NON-FATAL" errors will not cause the code to stop execution, whereas, "FATAL" errors will cause the code to stop execution after input error checking has been completed.

An example output from CONERR is shown in Figure 21. This figure illustrates the array of input errors checked by CONERR. Several additional features of the output are as follows:

- All user defined input cards are assigned a sequential "line number". This serves to identify user inputs from the code generated inputs (all code-created input cards are not identified with a "line number"). This scheme also permits the user to quickly identify those input cards in error so that efficient correction of input errors can be performed.

- All input cards are listed as input by the user. To the right of each input card is a listing of any errors encountered in processing that card. If no such error message appears then the input was interpreted as being correct.

- In many cases alphanumeric constants are available (see Table 3). Hence the user does not need to memorize a numeric scheme of "flags". Since some computers do not recognize alphanumeric constants as namelist constants, they are automatically converted by the code to their numeric equivalent. A message is printed to identify the substitutions performed. The example input ir Figure 21 shows replacements for CONE and OGIVE.

In order to permit column independent inputs the code will automatically adjust some of the input cards to begin in columns 1 or 2. All control cards will be automatically shifted to start in column 1; all namelists which begin in column 1 will be shifted to column 2. If any input card cannot be shifted to conform to this scheme, an error message will be produced. As a general rule, column 80 of namelist inputs should be left blank so that the code can shift the card image, if necessary.

4.1.2 Listing of Case Input Data

Figure 22 shows the first page of outputs for a case without CONERR detected errors. Then Figure 23 shows the next page of output which lists all input cards for the case (down to the NEXT CASE control card). If the input for a case is from a previous case (through use of the SAVE control card) only the new case inputs are listed. All saved inputs are not repeated in subsequent case input summaries.

After the case data have been read, the data set-up for the case is analyzed by the case major error checking module (MAJERR). The purpose of this second error checking is to insure that the data input, although syntax error free, properly defines a case to be run. Examples of errors detected in MAJERR include valid flight condition inputs, valid reference condition inputs, and that geometry has been defined. In most cases errors detected by MAJERR are corrected with assumed defaults. If any MAJERR error message is produced, the user should verify the "fix-up" taken by the code. In some cases a "fix-up" is not possible; an appropriate error message and a suggestion for correcting the error is provided. If a "fix-up" is not possible the case will not run.

4.1.3 Case Total Configuration Aerodynamic Output Summary

As shown in Figure 24, the total configuration aerodynamics are provided in compact form for easy review. The aerodynamics are summarized as a function of angle of attack (ALPHA) in the user specified system of units. the nomenclature is as follows:

CN	- Normal force coefficient
CM	- Pitching moment coefficient
CA	- Axial force coefficient
CY	- Side force coefficient
CLN	- Yawing moment coefficient
CLL	- Rolling moment coefficient
CNA	- Normal force coefficient derivative with ALPHA
CMA	- Pitching moment coefficient derivative with ALPHA
CYB	- Side force coefficient derivative with BETA
CLNB	- Yawing moment coefficient derivative with BETA
CLLB	- Rolling moment coefficient derivative with BETA
CL	- Lift coefficient
CD	- Drag coefficient
CL/CD	- Lift to drag ratio
XCP	- Center of pressure from the moment reference center divided by reference length

All coefficients are based upon the reference areas and lengths specified at the top of the output page. The derivatives CNA and CMA are computed by numeric differentiation of the CN and CM curves, respectively; precise derivatives are only obtained when the angle of attack range specified is narrow. The derivatives CYB, CLNB and CLLB are determined by perturbing the sideslip angle by one degree, recalculating the configuration forces and moments, and then differencing with the user specified orientation. Hence, the longitudinal and lateral derivatives will probably not be numerically identical for those conditions which should produce identical results if they were both calculated by the same method.

A significant decrease in computational time is realized when the calculation of lateral-directional derivatives are suppressed using the control card NO LAT. For these cases, the CYB, CLNB, and CLLB data fields are filled with blanks.

When selecting TRIM, the output is provided in a form similar to Figure 25. When running a trim case the derivatives due to ALPHA and

BETA are not available. The panels which were deflected to trim the configuration are indicated by the "VARIED" citation next to them.

The format for the values of the numbers in the printed output has been assumed based on typical magnitudes for missile aerodynamic coefficients. In some cases, a user specified reference area and/or length will cause the results to underflow or overflow the format selected. For these cases the user should adjust his reference quantities by powers of ten to get the data to fit the format specified.

4.2 PARTIAL OUTPUT

Partial output consists of geometry calculation details, intermediate aerodynamic results, or auxiliary data, such as pressure distributions. Each of these output types are printed through the addition of control cards input for each case. In all cases, partial output requested for one case is not automatically selected for subsequent cases, and the control cards must be re-input. This permits the user to be selective on the amount and types of output desired.

A special control card PART permits the user to request all geometric and aerodynamic partial output. Due to the amount of output produced, this option should be used sparingly or when details of the calculations are desired.

The following paragraphs describe the output received when partial output is requested.

4.2.1 Geometric Partial Output

Details of the geometry are provided when the PART or PRINT GEOM control cards are included in the case inputs. Figure 26 shows the output created when the PRINT GEOM BODY control card is used. Detailed are the results of the geometric calculations for the body. Included are such items as planform area, surface (wetted) area, and the mold line contour.

If fins are present on the configuration, two types of fin geometry data are produced when PRINT GEOM FIN1 or PART is requeste As shown in Figure 27, the description of the panel airfoil section is provided. Following that, shown in Figure 28, is a summary of the major geometric characteristics of such planform; note that fin planform geometry data is given for one panel of each fin set, since it is assumed that each fin of a fin set is identical. If a panel is made up of multiple segments, the geometric data is provided by panel segment (each segment is assigned a number starting at the root). Total panel set of characteristics is also provided. This total panel data represents an equivalent straight-tapered panel, which is used for most of the aerodynamic calculations. The thickness-to-chord ratio shown for each segment is that value at the segment root; for the total panel, it is an "effective" value.

If an airbreathing inlet is specified the output is similar to that in Figure 29. This output reflects the user input definition for the inlet design specified. It is provided if the PRINT GEOM INLET or PART control cards are included in the input case.

4.2.2 Aerodynamic Partial Output

The output on the configuration aerodynamics is most extensive when PRINT AERO or PART is specified. Output is created for the body and each fin set on the configuration. In addition, for any subsonic/transonic Mach number (less than 1.4) an analysis by the Airfoil Section Module is made, which involves a potential low analysis of the airfoil section using conformal mapping. If a configuration has inlets additional partial output is included to summarize the inlet external aerodynamics.

If base-jet plume interaction calculations are specified (BASE=.TRUE. in namelist AXIBOD), then there will be one or two separate pages of output. Figure 30 shows an example of the first page of output. This page will always be printed if BASE=.TRUE. The base pressure coefficient, axial force coefficient, and freestream pressure and temperature ratios are shown versus angle of attack. Also, the incremental forces and moments due to separation are shown versus angle of attack. If extrapolation of the base pressures and separation conditions database occurs, a warning message is printed explaning what input variable required extrapolation. A second page of output containing the boattail separation parameters will be printed if there are any fins on the missile boattail. The separation location aft of the nose and the Mach cone angle are shown versus angle of attack for each panel on the fin set. Figure 31 shows an example of this page. This output is provided if the PRINT AERO BODY or PART control card is input.

The protuberance partial output is printed if PRINT AERO BODY or PART is used. This output will only be shown if the namelist PROTUB is present in the input file. Figure 32 is an example of the protuberance output. Protuberance type, location, number, and axial force coefficient are listed for each protuberance set. The total axial force coefficient or zero lift drag coefficient is printed at the bottom of the page.

As shown in Figure 33, the body alone partial aerodynamic output for normal force lists the axial force contributors, potential normal force (CN-POTENTIAL), viscous normal forces (CN-VISCOUS), potential pitching moment (CM-POTENTIAL), viscous pitching moment (CM-VISCOUS), and the crossflow drag coefficient (CDC). The cross-flow drag proportionality factor at subsonic and transonic speeds is also given for reference. These data are similar to that obtained for elliptical bodies.

Figure 34 details the fin normal force calculations by fin set. Each panel's contribution to the configuration normal force is described. The column titled CN-POTENTIAL is the potential contribution and the column titled CN-VISCOUS is the viscous contribution. Their sum is given in the column titled CN-TOTAL. CNAA is the nonlinear variation of normal force due to angle of attack and ALPHA EQUIV is the panel angle of attack due to its roll position on the body. Figure 35 illustrates the fin axial force contributors and Figure 36 presents an example of the fin pitching moment contributors.

The analysis by the Airfoil Section Module is provided in a format similar to Figure 37. If any Mach number specified produces supersonic flow on the airfoil surface, the message "CREST CRITICAL MACH NUMBER EXCEEDED" will be printed; approximation of the airfoil section data is then assumed. These fin aerodynamic increments are repeated for each fin set on the configuration. Note that the Airfoil Section Module assumes that the panels have sharp trailing edges. Any panel input with a non-sharp trailing edge will have its aerodynamic characteristics set as though the airfoil was "ideal". This assumption is approximate for preliminary design.

Figure 38 shows the aerodynamic output available when inlets are specified on the configuration. It is provided when PRINT AERO INLET or PART is specified in the case inputs. The aerodynamics summarized for inlets can include additive drag results if the user input the additive drag calculation flag. The maximum mass flow ratio is printed at the bottom of the page if the additive drag is calculated. If additive drag cannot be calculated, a warning message is printed.

After the aerodynamic details for each component of the configuration are output, the aerodynamic calculations for the synthesis of the complete configuration follows. For the example case, fin set 1 results would be followed by fin set 2 results for each of the following outputs:

- "FIN SET PRESENCE OF THE BODY" - This summarizes the aerodynamic incrementals of the most forward set of fins with the influence of the body. Figure 39 presents the example of this output. The left-most six columns include the effect of body-on-fin component interference. The right-most columns represent the contribution to each panel to configuration aerodynamics, and include the effect of body-on-fin interference, these values are, in effect, individual panel loads. The panel characteristic values included are "AEQn" (the panel equivalent (local) angle of attack) and

"CNn" (the panel normal force coefficient). The sign convention is as follows: a positive panel normal force, hence, equivalent angle of attack, produces a negative roll moment. Therefore, panels on the right side of the configuration will produce loads and angles of attack opposite in sign to those on the left side of the configuration even though they produce the same physical force loading.

- "BODY-FIN SET" - Aerodynamics for the body plus most forward set of fins configuration. It is produced through addition of the body alone and wing in presence of the body incrementals, described above. The results shown in Figure 40, include the component carryover factors K-W(B) (wing in presence of the body carryover due to angle of attack), K-B(W) (body in presence of the wing carryover due to angle of attack), KK-B(W) (body in presence of the wing carryover due to panel deflection), XCP-W(B) (wing in presence of the body carryover center of pressure), and XCP-B(W) (body in presence of the wing carryover center of pressure). This output is repeated for the body plus each additional aft fin set, if one exists on the configuration. This example includes two fin sets so the next page of partial output would look like Figure 41. If additional fin sets are present on the configuration additional pages are output with each one successively included.

- "CARRYOVER INTERFERENCE FACTORS" - This page of partial output summarizes the carryover factors listed in the paragraph above. These were included in the body plus fin set calculations. An example of this output is presented in Figure 42.

- "COMPLETE CONFIGURATION" - Complete configuration aerodynamics. This output was illustrated in Figure 24. The values are obtained by summing the body-wing and tail in the presence of the wing flow field data.

In addition to the output described above, more data is presented when the BUILD control card is used. Static aerodynamics are output for each configuration component. Body alone aerodynamics are shown in Figure 43. Fin alone aerodynamics are shown for each fin set present. Figure 44 shows the output for the first fin set. Static aerodynamics for a configuration with body plus most forward set of fins is given next. Figure 45 shows an example of this output. This output is repeated for configurations including the body plus each additional fin set present.

If the PRINT AERO BEND or PART control card is used, the code will compute and print panel bending moment coefficients for each fin set on a separate page. One page is shown in Figure 46. The sign convention is that assumed for the individual panel loads and equivalent angles of attack, noted above. The bending moment coefficients are based upon the reference area and longitudinal length given at the top of the page. The moments are referenced about the fin-body structure specified by the root chord span station.

Figure 47 illustrates the panel hinge moments coefficients computed when the control cards PRINT AERO HINGE or PART are used. The reference area and longitudinal reference length given at the top of the page are used. All moments are computed about the hinge line, which is defined using namelist DEFLCT.

If TRIM is specified, the user can selectively print the six untrimmed static aerodynamic tables used in the trim process. An example is shown in Figure 48. The code computes the six-component aerodynamics at ten deflection angles for each specified angle of attack, then interpolates for C_m=0. Note that this trim process can be used to create control authority data, effectively giving the user 10 deflection angles, 20 angles of attack, and 20 Mach numbers per input case.

4.2.3 Pressure Distribution Data

If the Mach number is supersonic ($M \geq 1.2$), the user has the option to print the surface pressure distributions over the body and fins. This option is selected only through the addition of the control card PRESSURES. Since three body alone supersonic methods are available (Van Dyke Hybrid, Second-Order Shock Expansion (SOSE), and Newtonian flow) the capability exists to output the pressure distribution data from any one of these methods. The method to be used in the calculation of the pressure data is controlled with the control cards SOSE and HYPER; if neither control card is input, the Van Dyke Hybrid method is selected. Because of the nature of the calculations, body alone pressures are printed for angles of attack less than or equal to 15 degrees when using the Hybrid or SOSE techniques.

The capability also exists for the user to output the pressure distribution data over fins at any Mach number greater than 1.05. This option is also controlled by the PRESSURES control card. Due to the nature of the method, only pressure distribution data at zero angle of attack is presently output.

Figures 49, 50, and 51 illustrate typical output produced when PRESSURES is specified. The format of Figure 49 is only available when SOSE is specified; all other body alone pressure methods produce output similar to

Figure 50 for bodies. Figure 51 is representative of fin pressure distribution output. Note that calculation of pressures is a time-consuming process; much higher computational times will be required.

All body pressure distribution data is based on a configuration that has body diameter of unity; that is, the configuration is expressed in calibers (or body diameters). The longitudinal stations at which pressure coefficient data is desired cannot be user specified; however, sufficient data is provided to permit accurate interpolation for most applications.

4.3 DYNAMIC DERIVATIVES

As shown in Figure 52, the total configuration dynamic derivatives are provided in compact form for easy interpretation. The dynamic derivatives are summarized as a function of angle of attack in the user specified units. The coefficients provided are as follows:

CNQ	Normal force coefficient due to pitch rate
CNAD	Normal force coefficient due to rate of change of angle of attack (α)
CMQ	Pitching moment coefficient due to pitch rate
CMAD	Pitching moment coefficient due to rate of change of angle of attack (α)

Note: For body alone and body + fin set data CMQ and CMAD are presented as the sum CMQ+CMAD.

The dynamic derivatives are printed after all static coefficients and partial static aerodynamics are printed. If a BUILD or PART card is input, additional dynamic derivatives for partial configurations and/or configuration components are printed.

4.4 EXTERNAL DATA FILES

The code has the capability to be used in conjunction with other missile design tools, such as post-processing plotting programs or trajectory programs. Fixed format aerodynamic data is output as an external data file with the addition of the PLOT control card. Included in this data file are the six component forces and moments based upon the user specified reference quantities. In order to print component buildup data to the plot file the BUILD and PLOT control cards must be present in the case.

An option to create a user specified format data file is also available. The control cards WRITE and FORMAT have been designed for easy access to this capability.

Both the PLOT output and output generated via the WRITE control are written to unit 3. Thus, if both PLOT and WRITE are used in the same run, the external data file will have both output formats in the same file.

4.5 EXTRAPOLATION MESSAGES AND ARRAY DUMPS

As shown in Figure 53, the extrapolation messages are summarized for all design charts which have been extrapolated during the execution of the case. Since many of the aerodynamic methods do not include design charts, but are either closed-form equations or complete theoretical methods, this option is most useful in the subsonic and transonic Mach regimes. Extrapolation messages are only provided if the control card PRINT EXTRAP appears in the case inputs. The data titled "ROUTINE TRACE-BACK" lists the subroutines called when the look-up was performed; "X" represents the independent variable and "Y" represents the dependent variable in the extrapolation.

When it is necessary to examine the values stored in internal data arrays the DUMP control card can be used. This control card causes the contents of the named data arrays to be printed in a form similar to Figure 54. Array dumps are provided for each Mach number of the input case, and represent the data block contents at aerodynamic calculation completion.

Note that all data arrays are initialized to a constant named "UNUSED", which is preset to a value of 1×10^{-30}. Hence, any array element which contains this constant was not changed during execution of the case (since it is highly unlikely that this constant will result from any calculation). This scheme permits rapid "tracking" of program calculation sequences while in "debug" mode.

```
                          THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *
                          AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
                                 CONERR - INPUT ERROR CHECKING

ERROR CODES - N* DENOTES THE NUMBER OF OCCURENCES OF EACH ERROR

A - UNKNOWN VARIABLE NAME

B - MISSING EQUAL SIGN FOLLOWING VARIABLE NAME

C - NON-ARRAY VARIABLE HAS AN ARRAY ELEMENT DESIGNATION - (N)

D - NON-ARRAY VARIABLE HAS MULTIPLE VALUES ASSIGNED

E - ASSIGNED VALUES EXCEED ARRAY DIMENSION

F - SYNTAX ERROR

   ******************************  INPUT DATA CARDS  ******************************

 1 *
 2 * INPUT ERROR CHECKING TEST CASES
 3 *
 4 CASEID CONERR ERROR CHECKING TEST CASE
 5                                            ** BLANK CARD - IGNORED
 6  $FLTCON MACH=1.,$                         ** ERROR **  1*A  0*B  0*C  0*D  0*E  0*F
                                              ** FATAL ERROR **
 7  $REFQ SREF 1.,$                           ** ERROR **  0*A  1*B  0*C  0*D  0*E  0*F
                                              ** FATAL ERROR **
 8  $REFQ ROUGH(2)=0.,$                       ** ERROR **  0*A  0*B  1*C  0*D  0*E  0*F
                                              ** FATAL ERROR **
 9  $REFQ LATREF=1.,1.,$                      ** ERROR **  0*A  0*B  0*C  1*D  0*E  0*F
                                              ** FATAL ERROR **
10  $FLTCON MACH(21)=0.6,                     ** ERROR **  0*A  0*B  0*C  0*D  1*E  0*F
                                              ** FATAL ERROR **
11  $END
12  $FLTCON MMACH=1,$                         ** ERROR **  0*A  0*B  0*C  0*D  0*E  1*F
13 BUILT                                      ** ERROR ** UNKNOWN CONTROL CARD - IGNORED
14  $AXIBOD TNOSE=CONE,$                      ** SUBSTITUTING NUMERIC FOR NAME CONE
15  $AXIBD LNOSE=1.,$                         ** ERROR ** UNKNOWN NAMELIST NAME
16  $AXIBOD TNOSE=CONE,TAFT=OGIVE,$           ** SUBSTITUTING NUMERIC FOR NAME CONE
                                              ** SUBSTITUTING NUMERIC FOR NAME OGIVE
17 DUMP $$$                                   ** ERROR **   1 INCORRECT ARRAY NAMES
18  $                                         ** ERROR ** UNKNOWN NAMELIST NAME
19 NEXT CASE

FATAL ERROR ENCOUNTERED IN CONERR.  EXECUTION TERMINATED.
```

Figure 21 Input Error Checking Output

```
                                        THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *
                                        AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
                                            CONERR - INPUT ERROR CHECKING

ERROR CODES - N* DENOTES THE NUMBER OF OCCURENCES OF EACH ERROR

A - UNKNOWN VARIABLE NAME

B - MISSING EQUAL SIGN FOLLOWING VARIABLE NAME

C - NON-ARRAY VARIABLE HAS AN ARRAY ELEMENT DESIGNATION - (N)

D - NON-ARRAY VARIABLE HAS MULTIPLE VALUES ASSIGNED

E - ASSIGNED VALUES EXCEED ARRAY DIMENSION

F - SYNTAX ERROR

   ******************************  INPUT DATA CARDS  ******************************

 1 CASEID PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
 2 SOSE
 3 DIM IN
 4 NO LAT
 5  $FLTCON NMACH=1.,MACH=2.36,REN=3.E6,
 6          NALPHA=8.,ALPHA=0.,4.,8.,12.,16.,20.,24.,28.,$
 7  $REFQ XCG=18.75,$
 8  $AXIBOD LNOSE=11.25,DNOSE=3.75,LCENTR=26.25,$
 9  $FINSET1 CHORD=6.96,0.,SSPAN=1.875,5.355,XLE=15.42,
10           SWEEP=0.,STA=1.,ZUPPER=2*0.02238,NPANEL=4.,
11           LMAXU=0.288,LER=2*0.015,LFLATU=0.428,PHIF=0.,$
12  $FINSET2 CHORD=5.585,2.792,SSPAN=1.875,6.260,XLE=31.915,
13           SWEEP=0.,STA=1.,ZUPPER=2*0.02238,NPANEL=4.,
14           LMAXU=0.288,LER=2*0.015,LFLATU=0.428,PHIF=0.,$
15 PART
16 BUILD
17 SAVE
18 NEXT CASE
```

Figure 22 Case Input Listing

```
                         THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *                          CASE  1
                         AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS                           PAGE  1
                                          CASE INPUTS

FOLLOWING ARE THE CARDS INPUT FOR THIS CASE

CASEID PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
SOSE
DIM IN
NO LAT
 $FLTCON NMACH=1.,MACH=2.36,REN=3.E6,
         NALPHA=8.,ALPHA=0.,4.,8.,12.,16.,20.,24.,28.,$
 $REFQ XCG=18.75,$
 $AXIBOD LNOSE=11.25,DNOSE=3.75,LCENTR=26.25,$
 $FINSET1 CHORD=6.96,0.,SSPAN=1.875,5.355,XLE=15.42,
          SWEEP=0.,STA=1.,ZUPPER=2*0.02238,NPANEL=4.,
          LMAXU=0.288,LER=2*0.015,LFLATU=0.428,PHIF=0.,$
 $FINSET2 CHORD=5.585,2.792,SSPAN=1.875,6.260,XLE=31.915,
          SWEEP=0.,STA=1.,ZUPPER=2*0.02238,NPANEL=4.,
          LMAXU=0.288,LER=2*0.015,LFLATU=0.428,PHIF=0.,$
PART
BUILD
SAVE
NEXT CASE

* WARNING * THE REFERENCE AREA IS UNSPECIFIED, DEFAULT VALUE ASSUMED

* WARNING * THE REFERENCE LENGTH IS UNSPECIFIED, DEFAULT VALUE ASSUMED

* WARNING * A CENTER SECTION IS DEFINED BUT THE BASE DIAMETER IS NOT INPUT. CYLINDRICAL SECTION ASSUMED.

THE BOUNDARY LAYER IS ASSUMED TO BE TURBULENT OVER ALL COMPONENTS OF THE CONFIGURATION

THE INPUT UNITS ARE IN INCHES, THE SCALE FACTOR IS   1.0000
```

Figure 23 Example of Default Substitutions for Incomplete Case Inputs

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
STATIC AERODYNAMICS FOR BODY-FIN SET 1 AND 2

CASE 1
PAGE 26

FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

	LONGITUDINAL			LATERAL DIRECTIONAL			DERIVATIVES (PER DEGREE) LONGITUDINAL		DERIVATIVES (PER DEGREE) LATERAL DIRECTIONAL		
ALPHA	CN	CM	CA	CY	CLN	CLL	CNA	CMA	CYB	CLNB	CLLB
0.00	0.000	0.000	0.368	0.000	0.000	0.000	2.586E-01	-3.424E-01			
4.00	1.124	-1.472	0.368	0.000	0.000	0.000	3.032E-01	-3.934E-01			
8.00	2.427	-3.149	0.368	0.000	0.000	0.000	3.715E-01	-4.803E-01			
12.00	4.102	-5.327	0.369	0.000	0.000	0.000	4.316E-01	-5.783E-01			
16.00	5.880	-7.779	0.369	0.000	0.000	0.000	4.413E-01	-6.214E-01			
20.00	7.632	-10.298	0.370	0.000	0.000	0.000	4.193E-01	-6.175E-01			
24.00	9.235	-12.719	0.371	0.000	0.000	0.000	4.034E-01	-5.909E-01			
28.00	10.859	-15.026	0.373	0.000	0.000	0.000	4.084E-01	-5.624E-01			

ALPHA	CL	CD	CL/CD	X-C.P.
0.00	0.000	0.368	0.000	-1.324
4.00	1.095	0.445	2.460	-1.310
8.00	2.352	0.702	3.349	-1.298
12.00	3.935	1.213	3.244	-1.299
16.00	5.550	1.976	2.809	-1.323
20.00	7.045	2.958	2.382	-1.349
24.00	8.286	4.095	2.023	-1.377
28.00	9.413	5.427	1.734	-1.384

PANEL DEFLECTION ANGLES (DEGREES)

FIN SET	FIN 1	FIN 2	FIN 3	FIN 4
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00

LINEAR DATA FOR BODY ALONE WAS GENERATED USING THE SECOND-ORDER SHOCK EXPANSION METHOD

Figure 24 Total Configuration Aerodynamic Output Summary

```
                              THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *                              CASE   1
                              AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS                               PAGE   8
                              PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
                                 TRIMMED STATIC AERODYNAMIC COEFFICIENTS

--------------------------------- FLIGHT CONDITIONS ------------------------------   ------------- REFERENCE DIMENSIONS ------------
 MACH    ALTITUDE   VELOCITY   PRESSURE  TEMPERATURE  REYNOLDS   SIDESLIP   ROLL       REF.      REF. LENGTH     MOMENT REF. CENTER
NUMBER                                                 NUMBER     ANGLE     ANGLE      AREA      LONG.   LAT.      LONG.   VERTICAL
            FT        FT/SEC    LB/IN**2     DEG R      1/FT       DEG       DEG       IN**2      IN      IN        IN        IN
 0.60                                                1.000E+06    0.00      0.00     11.045     3.750   3.750    18.750     0.000


             ALPHA        DELTA         CL            CD            CN            CA            CY            CLN           CLL

              0.00        0.0000       0.0000        0.2682        0.0000        0.2682        0.0000        0.0000        0.0000

              8.00       16.9428       3.8491        1.5803        4.0316        1.0292        0.0000        0.0000        0.0000

             16.00        *NT*          *NT*          *NT*          *NT*          *NT*          *NT*          *NT*          *NT*

PANELS FROM FIN SET 1 WERE DEFLECTED OVER THE RANGE  -25.0000 TO   20.0000 DEG.
    PANEL 1 WAS FIXED
    PANEL 2 WAS VARIED
    PANEL 3 WAS FIXED
    PANEL 4 WAS VARIED

NOTE - *NT* PRINTED WHEN NO TRIM POINT COULD BE FOUND
```

Figure 25 Trimmed Output Summary

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
AXISYMMETRIC BODY DEFINITION

CASE 1
PAGE 2

	---- NOSE ----	---- CENTERBODY ----	---- AFT BODY ----	---- TOTAL -----	
SHAPE	OGIVE	CYLINDER	--------		
LENGTH	11.2500	26.2500	0.0000	37.5000	IN
FINENESS RATIO	3.0000	7.0000	0.0000	10.0000	
PLANFORM AREA	28.2799	98.4376	0.0000	126.7175	IN**2
AREA CENTROID	7.0157	24.3750	0.0000	20.5008	IN FROM NOSE TIP
WETTED AREA	89.8180	309.2506	0.0000	399.0687	IN**2
VOLUME	66.7887	289.9221	0.0000	356.7109	IN**3
VOLUME CENTROID	7.7135	24.3750	0.0000	21.2554	IN FROM NOSE TIP

MOLD LINE CONTOUR

LONGITUDINAL STATIONS	0.0000	1.1250	2.2500	3.3750	4.5000	5.6250	6.7500	7.8750	9.0000	10.1250
	11.2500	13.8750	16.5000	19.1250	21.7500	24.3750	27.0000	29.6250	32.2500	34.8750
	37.5000*									
BODY RADII	0.0000	0.3644	0.6871	0.9693	1.2119	1.4159	1.5819	1.7104	1.8020	1.8568
	1.8750	1.8750	1.8750	1.8750	1.8750	1.8750	1.8750	1.8750	1.8750	1.8750
	1.8750*									

NOTE - * INDICATES SLOPE DISCONTINUOUS POINTS

Figure 26 Body Geometry Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
FIN SET NUMBER 1 AIRFOIL SECTION

CASE 1
PAGE 3

NACA 8-3-35.9-04.5-28.5

UPPER ABSCISSA	UPPER ORDINATE	LOWER ABSCISSA	LOWER ORDINATE	X-FRACTION CHORD	MEAN LINE	THICKNESS
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00100	0.00006	0.00100	-0.00006	0.00100	0.00000	0.00013
0.00200	0.00013	0.00200	-0.00013	0.00200	0.00000	0.00025
0.00300	0.00019	0.00300	-0.00019	0.00300	0.00000	0.00038
0.00400	0.00025	0.00400	-0.00025	0.00400	0.00000	0.00050
0.00500	0.00031	0.00500	-0.00031	0.00500	0.00000	0.00063
0.00600	0.00038	0.00600	-0.00038	0.00600	0.00000	0.00075
0.00800	0.00050	0.00800	-0.00050	0.00800	0.00000	0.00100
0.01000	0.00063	0.01000	-0.00063	0.01000	0.00000	0.00125
0.02000	0.00125	0.02000	-0.00125	0.02000	0.00000	0.00251
0.03000	0.00188	0.03000	-0.00188	0.03000	0.00000	0.00376
0.04000	0.00251	0.04000	-0.00251	0.04000	0.00000	0.00501
0.05000	0.00313	0.05000	-0.00313	0.05000	0.00000	0.00627
0.06000	0.00376	0.06000	-0.00376	0.06000	0.00000	0.00752
0.08000	0.00501	0.08000	-0.00501	0.08000	0.00000	0.01003
0.10000	0.00627	0.10000	-0.00627	0.10000	0.00000	0.01253
0.12000	0.00752	0.12000	-0.00752	0.12000	0.00000	0.01504
0.14000	0.00877	0.14000	-0.00877	0.14000	0.00000	0.01755
0.16000	0.01003	0.16000	-0.01003	0.16000	0.00000	0.02006
0.18000	0.01128	0.18000	-0.01128	0.18000	0.00000	0.02256
0.20000	0.01253	0.20000	-0.01253	0.20000	0.00000	0.02507
0.40000	0.02250	0.40000	-0.02250	0.40000	0.00000	0.04500
0.42000	0.02250	0.42000	-0.02250	0.42000	0.00000	0.04500
0.45000	0.02250	0.45000	-0.02250	0.45000	0.00000	0.04500
0.50000	0.02250	0.50000	-0.02250	0.50000	0.00000	0.04500
0.55000	0.02250	0.55000	-0.02250	0.55000	0.00000	0.04500
0.60000	0.02250	0.60000	-0.02250	0.60000	0.00000	0.04500
0.65000	0.02212	0.65000	-0.02212	0.65000	0.00000	0.04424
0.70000	0.01896	0.70000	-0.01896	0.70000	0.00000	0.03792
0.75000	0.01580	0.75000	-0.01580	0.75000	0.00000	0.03160
0.80000	0.01264	0.80000	-0.01264	0.80000	0.00000	0.02528
0.82000	0.01138	0.82000	-0.01138	0.82000	0.00000	0.02275
0.84000	0.01011	0.84000	-0.01011	0.84000	0.00000	0.02022
0.86000	0.00885	0.86000	-0.00885	0.86000	0.00000	0.01770
0.88000	0.00758	0.88000	-0.00758	0.88000	0.00000	0.01517
0.90000	0.00632	0.90000	-0.00632	0.90000	0.00000	0.01264
0.92000	0.00506	0.92000	-0.00506	0.92000	0.00000	0.01011
0.94000	0.00379	0.94000	-0.00379	0.94000	0.00000	0.00758
0.96000	0.00253	0.96000	-0.00253	0.96000	0.00000	0.00506
0.98000	0.00126	0.98000	-0.00126	0.98000	0.00000	0.00253
1.00000	0.00000	1.00000	0.00000	1.00000	0.00000	0.00000

Figure 27 Airfoil Geometry Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
GEOMETRIC RESULTS FOR FIN SETS

CASE 1
PAGE 5

FIN SET NUMBER 1
(DATA FOR ONE PANEL ONLY)

SEGMENT NUMBER	PLANFORM AREA IN**2	TAPER RATIO	ASPECT RATIO	LEADING EDGE SWEEP DEG	TRAILING EDGE SWEEP DEG	MEAN AERODYNAMIC CHORD IN	LEADING M.A.C. POSITION IN	LATERAL M.A.C. POSITION IN	THICKNESS TO CHORD RATIO
1	12.11040	0.0000	1.00000	63.43495	0.00000	4.6400	2.3200	3.0350	0.04500
TOTAL	12.11040	0.0000	1.00000	63.43495	0.00000	4.6400	2.3200	3.0350	0.04500

FIN SET NUMBER 2
(DATA FOR ONE PANEL ONLY)

SEGMENT NUMBER	PLANFORM AREA IN**2	TAPER RATIO	ASPECT RATIO	LEADING EDGE SWEEP DEG	TRAILING EDGE SWEEP DEG	MEAN AERODYNAMIC CHORD IN	LEADING M.A.C. POSITION IN	LATERAL M.A.C. POSITION IN	THICKNESS TO CHORD RATIO
1	18.36658	0.4999	1.04691	32.49486	0.00000	4.3437	1.2413	3.8238	0.04500
TOTAL	18.36658	0.4999	1.04691	32.49486	0.00000	4.3437	1.2413	3.8238	0.04500

Figure 28 Fin Geometry Output

```
                 THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *                          CASE   1
                 AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS                           PAGE   3
                          2D SIDE INLET PHI=90,270
                               INLET GEOMETRY

 INLET IS A SIDE MOUNTED TWO-DIMENSIONAL TYPE

 THE INLETS ARE OPEN

 EXTERNAL COMPRESSION RAMP ANGLE (DEG) =  12.22

 NUMBER OF INLETS = 2

 INLET ANGULAR ROLL POSITIONS FROM TOP VERTICAL CENTER (DEG)
      (SAME CONVENTION AS FIN ROLL POSITIONS)
       90.0      270.0

 LONGITUDINAL DISTANCE FROM MISSILE NOSE TIP TO
 INLET LEADING EDGE =  35.69

        INLET POSITIONS RELATIVE TO THE LEADING EDGE
        POSITION          LONGITUDINAL      WIDTH        HEIGHT
  TOP LIP LEADING EDGE        0.000         3.600         0.000
  COWL LIP LEADING EDGE       8.694         4.064         4.073
     MID BODY START          13.335         4.064         4.844
     BOATTAIL START          56.071         4.064         4.064
      BOATTAIL END           70.993         2.286         2.286

 LONGITUDINAL DISTANCE FROM INLET LEADING EDGE TO
 DIVERTER LEADING EDGE =   7.75

 DIVERTER LENGTH =  12.45

 HEIGHT OF DIVERTER LEADING EDGE =   0.25
```

Figure 29 Inlet Geometry Output

```
                      THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *                        CASE   1
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                             TEST CASE FOR BASPRS IMPLEMENTATION
                          BASE-JET PLUME INTERACTION FLOW PARAMETERS

 -------------------------------- FLIGHT CONDITIONS ------------------------------   ------------- REFERENCE DIMENSIONS ------------
 MACH    ALTITUDE   VELOCITY   PRESSURE  TEMPERATURE  REYNOLDS   SIDESLIP   ROLL      REF.       REF. LENGTH      MOMENT REF. CENTER
 NUMBER                                               NUMBER     ANGLE      ANGLE     AREA      LONG.    LAT.     LONG.     VERTICAL
              FT       FT/SEC    LB/IN**2     DEG R    1/FT       DEG        DEG      IN**2      IN       IN       IN          IN
  2.00        0.00    2232.53   1.470E+01    5186.70  1.414E+07     0.00       0.00   19.635     5.000    5.000    15.000       0.000


           WARNING EXTRAPOLATION WILL BE REQUIRED FOR THE FOLLOWING CONDITIONS:

           * ANGLE OF ATTACK LESS THAN 0.0


           ------- BASE FLOW PARAMETERS --------          ------ INCREMENTAL FORCE AND MOMENT DATA ------
    ALPHA    CP-BASE  CA-BASE  TBASE/TINF  PBASE/PINF            DELTA CN  DELTA CM  DELTA CA

   -2.00     0.0926  -0.0073    4.0996     1.2592              -0.0023    0.0035   -0.0218
    0.00     0.0926  -0.0073    4.0996     1.2592               0.0000    0.0000   -0.0218
    2.00     0.0926  -0.0073    4.0996     1.2592               0.0023   -0.0035   -0.0218
```

Figure 30 Base-Jet Plume Interaction Output - Page 1

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THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
TEST CASE FOR BASPRS IMPLEMENTATION
BASE-JET PLUME INTERACTION FLOW PARAMETERS

FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.00	0.00	2232.53	1.470E+01	5186.70	1.414E+07	0.00	0.00	19.635	5.000	5.000	15.000	0.000

BOATTAIL SEPARATION PARAMETERS

	PANEL 1 PHI= 45.0		PANEL 2 PHI=135.0		PANEL 3 PHI=225.0		PANEL 4 PHI=315.0	
ALPHA	X-SEP (FT)	MACH CONE ANGLE	X-SEP (FT)	MACH CONE ANGLE	X-SEP (FT)	MACH CONE ANGLE	X-SEP (FT)	MACH CONE ANGLE
-2.00	1.881	28.586	1.857	31.414	1.857	31.414	1.881	28.586
0.00	1.867	30.000	1.867	30.000	1.867	30.000	1.867	30.000
2.00	1.854	31.414	1.877	28.585	1.877	28.586	1.854	31.414

Figure 31 Base-Jet Plume Interaction Output - Page 2

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PROTUBERANCE DRAG EXAMPLE CASE
PROTUBERANCE OUTPUT

CASE 1
PAGE 2

FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
0.40	0.00				3.000E+06	0.00	0.00	113.097	12.000	12.000	39.000	0.000

PROTUBERANCE AXIAL FORCE COEFFICIENT IS CALCULATED AT ZERO ANGLE OF ATTACK AND ASSUMED TO REMAIN CONSTANT OVER ALL ANGLES OF ATTACK. PROTUBERANCES ARE CONSIDERED TO BE PART OF THE BODY WHEN CALCULATING TOTAL BODY AXIAL FORCE. THEREFORE, PROTUBERANCE AXIAL FORCE INCREMENT IS INCLUDED IN THE TOTAL CONFIGURATION AERODYNAMICS SECTION.

PROTUBERANCE CALCULATIONS

NUMBER	TYPE	LONGITUDINAL LOCATION (IN)	NUMBER AT LOCATION	INDIVIDUAL CA	TOTAL CA
1	FAIRING	14.000	2	0.0027	0.0053
2	VERTICAL CYLINDER	22.000	4	0.0018	0.0073
3	LAUNCH SHOE	39.000	2	0.0034	0.0068
4	FLAT PLATE OR BLOCK	56.000	1	0.0012	0.0012

TOTAL CA DUE TO PROTUBERANCES = 0.0206

Figure 32 Protuberance Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
BODY ALONE PARTIAL OUTPUT

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FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

ALPHA	CA-FRICTION	CA-PRESSURE/WAVE	CA-BASE	CA-ALPHA
0.000	0.08447	0.10301	0.12540	0.00000
4.000	0.08459	0.10299	0.12540	0.00000
8.000	0.08493	0.10293	0.12540	0.00000
12.000	0.08551	0.10284	0.12540	0.00000
16.000	0.08633	0.10271	0.12540	0.00000
20.000	0.08740	0.10255	0.12540	0.00000
24.000	0.08871	0.10235	0.12540	0.00000
28.000	0.09028	0.10213	0.12540	0.00000

NOTE - THE BASE DRAG INCREMENT IS NOT INCLUDED IN THE AXIAL FORCE CALCULATIONS

CROSS FLOW DRAG PROPORTIONALITY FACTOR = 1.00000

ALPHA	CN-POTENTIAL	CN-VISCOUS	CM-POTENTIAL	CM-VISCOUS	CDC
0.000	0.0000	0.0000	0.0000	0.0000	0.2800
4.000	0.2213	0.0248	0.5822	-0.0116	0.4446
8.000	0.4375	0.1809	1.1510	-0.0845	0.8140
12.000	0.6436	0.6578	1.6932	-0.3071	1.3264
16.000	0.8350	1.3075	2.1965	-0.6105	1.5000
20.000	1.0072	2.0045	2.6497	-0.9359	1.4935
24.000	1.1566	2.6081	3.0427	-1.2177	1.3741
28.000	1.2800	3.3299	3.3671	-1.5547	1.3168

Figure 33 Body Alone Aerodynamic Partial Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
FIN SET 1 CN PARTIAL OUTPUT

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PAGE 7

FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE FT	VELOCITY FT/SEC	PRESSURE LB/IN**2	TEMPERATURE DEG R	REYNOLDS NUMBER 1/FT	SIDESLIP ANGLE DEG	ROLL ANGLE DEG	REF. AREA IN**2	REF. LENGTH LONG. IN	REF. LENGTH LAT. IN	MOMENT REF. CENTER LONG. IN	MOMENT REF. CENTER VERTICAL IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

POTENTIAL NORMAL FORCE SLOPE AT ALPHA ZERO (1 PANEL), CNA = 0.03186/DEG

PANEL NO.	ALPHA TOTAL DEG	FIN PHI DEG	ALPHA EQUIV DEG	CNAA	CN POTENTIAL	CN VISCOUS	CN TOTAL
1	0.000	0.000	0.000	1.75439	0.00000	0.00000	0.00000
2	0.000	90.000	0.000	1.75439	0.00000	0.00000	0.00000
3	0.000	180.000	0.000	1.75439	0.00000	0.00000	0.00000
4	0.000	270.000	0.000	1.75439	0.00000	0.00000	0.00000
SET					0.00000	0.00000	0.00000
1	4.000	0.000	0.000	1.75439	0.00000	0.00000	0.00000
2	4.000	90.000	4.000	1.56610	0.12703	0.00762	0.13465
3	4.000	180.000	0.000	1.75439	0.00000	0.00000	0.00000
4	4.000	270.000	4.000	1.56610	0.12703	0.00762	0.13465
SET					0.25406	0.01524	0.26930
1	8.000	0.000	0.000	1.75439	0.00000	0.00000	0.00000
2	8.000	90.000	8.000	1.38431	0.25159	0.02681	0.27840
3	8.000	180.000	0.000	1.75439	0.00000	0.00000	0.00000
4	8.000	270.000	8.000	1.38431	0.25159	0.02681	0.27840
SET					0.50318	0.05363	0.55680
1	12.000	0.000	0.000	1.75439	0.00000	0.00000	0.00000
2	12.000	90.000	12.000	1.21073	0.37125	0.05234	0.42359
3	12.000	180.000	0.000	1.75439	0.00000	0.00000	0.00000
4	12.000	270.000	12.000	1.21073	0.37125	0.05234	0.42359
SET					0.74250	0.10467	0.84717

Figure 34 Fin Normal Force Partial Output

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                                        PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
                                             FIN SET 1 CA PARTIAL OUTPUT

------------------------------- FLIGHT CONDITIONS -----------------------------   ------------ REFERENCE DIMENSIONS ------------
 MACH    ALTITUDE   VELOCITY   PRESSURE  TEMPERATURE  REYNOLDS   SIDESLIP   ROLL       REF.      REF. LENGTH     MOMENT REF. CENTER
NUMBER                                                 NUMBER     ANGLE     ANGLE      AREA      LONG.    LAT.     LONG.    VERTICAL
            FT        FT/SEC    LB/IN**2     DEG R      1/FT       DEG       DEG      IN**2       IN       IN       IN        IN
 2.36                                                3.000E+06     0.00      0.00     11.045     3.750    3.750   18.750     0.000

 SINGLE FIN PANEL ZERO-LIFT AXIAL FORCE COMPONENTS

     SKIN FRICTION         0.00755
     SUBSONIC PRESSURE     0.00000
     TRANSONIC WAVE        0.00000
     SUPERSONIC WAVE       0.00598
     LEADING EDGE          0.00108
     TRAILING EDGE         0.00000
     TOTAL CAO             0.01461

 FIN AXIAL FORCE DUE TO ANGLE OF ATTACK

    ALPHA       CA DUE TO ALPHA   CA-TOTAL (4 FINS)
     DEG
    0.000          0.00000            0.05845
    4.000          0.00000            0.05845
    8.000          0.00000            0.05845
   12.000          0.00000            0.05845
   16.000          0.00000            0.05845
   20.000          0.00000            0.05845
   24.000          0.00000            0.05845
   28.000          0.00000            0.05845
```

Figure 35 Fin Axial Force Partial Output

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PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
FIN SET 1 CM PARTIAL OUTPUT

FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

CENTER OF PRESSURE FOR LINEAR CN = -0.35552 (CALIBERS FROM C.G.)
CENTER OF PRESSURE FOR NON-LINEAR CN = -0.34933 (CALIBERS FROM C.G.)

ALPHA DEG.	CM LINEAR	CM NON-LINEAR	CM TOTAL
0.00000	0.00000	0.00000	0.00000
4.00000	-0.09032	-0.00532	-0.09565
8.00000	-0.17889	-0.01873	-0.19762
12.00000	-0.26397	-0.03657	-0.30054
16.00000	-0.34392	-0.05663	-0.40055
20.00000	-0.41717	-0.07651	-0.49368
24.00000	-0.48230	-0.09492	-0.57722
28.00000	-0.53805	-0.11338	-0.65142

Figure 36 Fin Pitching Moment Partial Output

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                                       FIN SET 1 SECTION AERODYNAMICS

                   IDEAL ANGLE OF ATTACK =   0.00000 DEG.

               ZERO LIFT ANGLE OF ATTACK =   0.00000 DEG.

                 IDEAL LIFT COEFFICIENT =   0.00000

    ZERO LIFT PITCHING MOMENT COEFFICIENT =   0.00000

             MACH ZERO LIFT-CURVE-SLOPE =   0.09275 /DEG.

                    LEADING EDGE RADIUS =   0.00323 FRACTION CHORD

              MAXIMUM AIRFOIL THICKNESS =   0.04500 FRACTION CHORD

                               DELTA-Y =   0.36664 PERCENT CHORD


         MACH= 0.6000 LIFT-CURVE-SLOPE =   0.11536 /DEG.     XAC =   0.28302     MAX. LIFT =   0.73826
```

Figure 37 Airfoil Section Aerodynamic Partial Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
2D SIDE INLET PHI=90,270
INLET AERODYNAMIC INCREMENTALS

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------- FLIGHT CONDITIONS -------								------- REFERENCE DIMENSIONS -------				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	M	M/SEC	NT/CM**2	DEG K	1/ M	DEG	DEG	CM**2	CM	CM	CM	CM
2.50	0.00	850.81	4.758E-02	2881.50	5.796E+07	0.00	0.00	45.604	7.620	7.620	53.340	0.000

ALPHA	CN-INLET	CM-INLET	CA-INLET	CA-ADD	CY-INLET	CLN-INLET
-4.00	-1.0229	-0.9977	0.0796	0.0655	0.0000	0.0000
0.00	0.0000	0.0000	0.0796	0.0655	0.0000	0.0000
4.00	1.0229	0.9977	0.0796	0.0655	0.0000	0.0000
8.00	2.2836	1.3925	0.0796	0.0655	0.0000	0.0000

NOTE; CA-ADD IS INLET ADDITIVE DRAG COEFFICIENT FOR AN INLET MASS FLOW RATIO OF 0.75

NOTE; THE MAXIMUM MASS FLOW RATIO FOR THIS INLET AT THESE FLIGHT CONDITIONS IS 0.77

Figure 38 Inlet Aerodynamic Partial Output

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AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
AERODYNAMIC FORCE AND MOMENT SYNTHESIS

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----- FLIGHT CONDITIONS -----								----- REFERENCE DIMENSIONS -----				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

ANGLE OF ATTACK, DEG.	---FIN SET 1 IN PRESENCE OF THE BODY--- CN	CM	CA	CY	CLN	CLL
0.0000	0.0000	0.0000	0.0584	0.0000	0.0000	0.0000
4.0000	0.3541	-0.1259	0.0584	0.0000	0.0000	0.0000
8.0000	0.7285	-0.2590	0.0584	0.0000	0.0000	0.0000
12.0000	1.0919	-0.3882	0.0584	0.0000	0.0000	0.0000
16.0000	1.3782	-0.4900	0.0584	0.0000	0.0000	0.0000
20.0000	1.6192	-0.5756	0.0584	0.0000	0.0000	0.0000
24.0000	1.8547	-0.6594	0.0584	0.0000	0.0000	0.0000
28.0000	2.0750	-0.7377	0.0584	0.0000	0.0000	0.0000

---PANEL CHARACTERISTICS--- PANEL NUMBER	AEQ (IN PANEL AXIS SYS.) DEG.	CN
1	0.0000	0.0000
2	0.0000	0.0000
3	0.0000	0.0000
4	0.0000	0.0000
1	0.0000	0.0000
2	5.1963	0.1770
3	0.0000	0.0000
4	-5.1963	-0.1770
1	0.0000	0.0000
2	10.3582	0.3642
3	0.0000	0.0000
4	-10.3582	-0.3642
1	0.0000	0.0000
2	15.4529	0.5459
3	0.0000	0.0000
4	-15.4529	-0.5459
1	0.0000	0.0000
2	19.7740	0.6891
3	0.0000	0.0000
4	-19.7740	-0.6891
1	0.0000	0.0000
2	23.8356	0.8096
3	0.0000	0.0000
4	-23.8356	-0.8096
1	0.0000	0.0000
2	28.3397	0.9274
3	0.0000	0.0000
4	-28.3397	-0.9274
1	0.0000	0.0000
2	32.7188	1.0375
3	0.0000	0.0000
4	-32.7188	-1.0375

Figure 39 Fin Set in Presence of the Body Partial Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
AERODYNAMIC FORCE AND MOMENT SYNTHESIS

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FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

SYNTHESIS AERODYNAMICS FOR BODY-FIN SET 1

ANGLE OF ATTACK, DEG.	CN	CM	CA	CY	CLN	CLL
0.0000	0.0000	0.0000	0.2459	0.0000	0.0000	0.0000
4.0000	0.7170	0.3174	0.2460	0.0000	0.0000	0.0000
8.0000	1.5871	0.5457	0.2463	0.0000	0.0000	0.0000
12.0000	2.7534	0.6054	0.2468	0.0000	0.0000	0.0000
16.0000	3.9751	0.6007	0.2475	0.0000	0.0000	0.0000
20.0000	5.1647	0.5562	0.2484	0.0000	0.0000	0.0000
24.0000	6.2309	0.4989	0.2495	0.0000	0.0000	0.0000
28.0000	7.3689	0.3289	0.2509	0.0000	0.0000	0.0000

Figure 40 Body Plus Fin Set Partial Output

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AERODYNAMIC FORCE AND MOMENT SYNTHESIS
```

----- FLIGHT CONDITIONS -----								----- REFERENCE DIMENSIONS -----				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

SYNTHESIS AERODYNAMICS FOR BODY-FIN SET 1 AND 2

ANGLE OF ATTACK, DEG.	CN	CM	CA	CY	CLN	CLL
0.0000	0.0000	0.0000	0.3676	0.0000	0.0000	0.0000
4.0000	1.1236	-1.4716	0.3677	0.0000	0.0000	0.0000
8.0000	2.4267	-3.1490	0.3680	0.0000	0.0000	0.0000
12.0000	4.1015	-5.3266	0.3685	0.0000	0.0000	0.0000
16.0000	5.8796	-7.7793	0.3692	0.0000	0.0000	0.0000
20.0000	7.6316	-10.2981	0.3701	0.0000	0.0000	0.0000
24.0000	9.2350	-12.7195	0.3712	0.0000	0.0000	0.0000
28.0000	10.8586	-15.0261	0.3726	0.0000	0.0000	0.0000

Figure 41 Body Plus Two Fin Sets Partial Output

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                         PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
                            AERODYNAMIC FORCE AND MOMENT SYNTHESIS

-------------------------------- FLIGHT CONDITIONS ------------------------------   ------------- REFERENCE DIMENSIONS ------------
MACH     ALTITUDE   VELOCITY   PRESSURE  TEMPERATURE  REYNOLDS   SIDESLIP   ROLL      REF.      REF. LENGTH       MOMENT REF. CENTER
NUMBER                                                 NUMBER     ANGLE     ANGLE     AREA     LONG.     LAT.      LONG.    VERTICAL
            FT        FT/SEC    LB/IN**2     DEG R      1/FT       DEG       DEG      IN**2     IN        IN        IN         IN
 2.36                                                3.000E+06    0.00      0.00    11.045    3.750     3.750    18.750      0.000

                                                    CARRYOVER INTERFERENCE FACTORS
  FIN SET          K-W(B)          K-B(W)         KK-W(B)        KK-B(W)        XCP-W(B)       XCP-B(W)

     1          1.300543E+00    4.287630E-01   9.347357E-01   3.658075E-01   3.555199E-01   1.090305E+00
     2          1.252313E+00    1.126451E-01   9.358542E-01   3.164592E-01   4.390780E+00   4.503570E+00

                                                      PANEL CENTERS OF PRESSURE
                                                    FIN SET      X-CP        Y-CP/(B/2)

                                                       1      3.5552E-01    3.2301E-01
                                                       2      4.3908E+00    4.1973E-01
```

Figure 42 Carryover Interference Factors Partial Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
BODY ALONE STATIC AERODYNAMIC CHARACTERISTICS

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FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

	LONGITUDINAL			LATERAL DIRECTIONAL			DERIVATIVES (PER DEGREE) LONGITUDINAL		LATERAL DIRECTIONAL		
ALPHA	CN	CM	CA	CY	CLN	CLL	CNA	CMA	CYB	CLNB	CLLB
0.00	0.000	0.000	0.187	0.000	0.000	0.000	4.579E-02	1.520E-01	-4.972E-02	-1.497E-01	0.000E+00
4.00	0.246	0.571	0.188	0.000	0.000	0.000	7.728E-02	1.333E-01	-6.189E-02	-1.421E-01	0.000E+00
8.00	0.618	1.066	0.188	0.000	0.000	0.000	1.317E-01	1.019E-01	-7.721E-02	-1.322E-01	0.000E+00
12.00	1.301	1.386	0.188	0.000	0.000	0.000	1.904E-01	6.493E-02	-1.071E-01	-1.136E-01	0.000E+00
16.00	2.143	1.586	0.189	0.000	0.000	0.000	2.138E-01	4.097E-02	-1.305E-01	-9.644E-02	0.000E+00
20.00	3.012	1.714	0.190	0.000	0.000	0.000	2.027E-01	2.987E-02	-1.445E-01	-8.213E-02	0.000E+00
24.00	3.765	1.825	0.191	0.000	0.000	0.000	1.997E-01	1.232E-02	-1.476E-01	-7.150E-02	0.000E+00
28.00	4.610	1.812	0.192	0.000	0.000	0.000	2.228E-01	-1.862E-02	-1.513E-01	-5.946E-02	0.000E+00

ALPHA	CL	CD	CL/CD	X-C.P.
0.00	0.000	0.187	0.000	3.320
4.00	0.232	0.204	1.138	2.318
8.00	0.586	0.272	2.154	1.725
12.00	1.234	0.455	2.713	1.065
16.00	2.007	0.772	2.599	0.740
20.00	2.765	1.209	2.288	0.569
24.00	3.362	1.706	1.971	0.485
28.00	3.980	2.334	1.705	0.393

LINEAR DATA FOR BODY ALONE WAS GENERATED USING THE SECOND-ORDER SHOCK EXPANSION METHOD

Figure 43 Body Alone Static Aerodynamic Partial Output

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                                   THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *                              CASE   1
                                   AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS                               PAGE  23
                                   PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
                                   FIN 1 ALONE STATIC AERODYNAMIC CHARACTERISTICS

 -------------------------------- FLIGHT CONDITIONS ------------------------------   ------------- REFERENCE DIMENSIONS ------------
  MACH    ALTITUDE  VELOCITY  PRESSURE  TEMPERATURE  REYNOLDS   SIDESLIP    ROLL        REF.      REF.  LENGTH    MOMENT REF. CENTER
 NUMBER                                              NUMBER      ANGLE      ANGLE       AREA      LONG.   LAT.     LONG.    VERTICAL
             FT       FT/SEC   LB/IN**2    DEG R      1/FT        DEG        DEG        IN**2     IN      IN       IN        IN
  2.36                                              3.000E+06     0.00       0.00     11.045    3.750   3.750   18.750     0.000

                                                                         ------------------ DERIVATIVES (PER DEGREE) -----------------
           ------ LONGITUDINAL -----         --- LATERAL DIRECTIONAL ---          LONGITUDINAL              LATERAL DIRECTIONAL
  ALPHA       CN        CM        CA          CY        CLN       CLL          CNA        CMA          CYB          CLNB          CLLB

   0.00     0.000     0.000     0.058                                        6.505E-02  -2.312E-02
   4.00     0.269    -0.096     0.058                                        6.960E-02  -2.470E-02
   8.00     0.557    -0.198     0.058                                        7.223E-02  -2.561E-02
  12.00     0.847    -0.301     0.058                                        7.159E-02  -2.537E-02
  16.00     1.129    -0.401     0.058                                        6.816E-02  -2.414E-02
  20.00     1.392    -0.494     0.058                                        6.235E-02  -2.208E-02
  24.00     1.628    -0.577     0.058                                        5.569E-02  -1.972E-02
  28.00     1.838    -0.651     0.058                                        4.913E-02  -1.738E-02
                                              ALPHA       CL        CD       CL/CD    X-C.P.

                                               0.00     0.000     0.058     0.000    -0.355
                                               4.00     0.265     0.077     3.432    -0.355
                                               8.00     0.543     0.135     4.013    -0.355
                                              12.00     0.817     0.233     3.500    -0.355
                                              16.00     1.070     0.368     2.910    -0.355
                                              20.00     1.288     0.531     2.426    -0.355
                                              24.00     1.464     0.716     2.045    -0.354
                                              28.00     1.595     0.914     1.745    -0.354
```

Figure 44 Fin Alone Static Aerodynamic Partial Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
STATIC AERODYNAMICS FOR BODY-FIN SET 1

CASE 1
PAGE 25

FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

	LONGITUDINAL			LATERAL DIRECTIONAL			DERIVATIVES (PER DEGREE) LONGITUDINAL		LATERAL DIRECTIONAL		
ALPHA	CN	CM	CA	CY	CLN	CLL	CNA	CMA	CYB	CLNB	CLLB
0.00	0.000	0.000	0.246	0.000	0.000	0.000	1.602E-01	9.052E-02			
4.00	0.717	0.317	0.246	0.000	0.000	0.000	1.983E-01	6.820E-02			
8.00	1.587	0.546	0.246	0.000	0.000	0.000	2.542E-01	3.598E-02			
12.00	2.753	0.605	0.247	0.000	0.000	0.000	2.985E-01	6.878E-03			
16.00	3.975	0.601	0.247	0.000	0.000	0.000	3.014E-01	-6.152E-03			
20.00	5.165	0.556	0.248	0.000	0.000	0.000	2.819E-01	-1.272E-02			
24.00	6.231	0.499	0.250	0.000	0.000	0.000	2.755E-01	-2.841E-02			
28.00	7.369	0.329	0.251	0.000	0.000	0.000	2.935E-01	-5.662E-02			

ALPHA	CL	CD	CL/CD	X-C.P.
0.00	0.000	0.246	0.000	0.565
4.00	0.698	0.295	2.363	0.443
8.00	1.537	0.465	3.308	0.344
12.00	2.642	0.814	3.246	0.220
16.00	3.753	1.334	2.814	0.151
20.00	4.768	2.000	2.384	0.108
24.00	5.591	2.762	2.024	0.080
28.00	6.389	3.681	1.736	0.045

PANEL DEFLECTION ANGLES (DEGREES)

FIN SET	FIN 1	FIN 2	FIN 3	FIN 4
1	0.00	0.00	0.00	0.00

LINEAR DATA FOR BODY ALONE WAS GENERATED USING THE SECOND-ORDER SHOCK EXPANSION METHOD

Figure 45 Body Plus Fin Static Aerodynamic Partial Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
FIN SET 1 PANEL BENDING MOMENTS (ABOUT EXPOSED ROOT CHORD)

CASE 1
PAGE 18

FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

ANGLE OF ATTACK, DEG.	PANEL 1	PANEL 2	PANEL 3	PANEL 4
0.0000	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4.0000	0.00000E+00	5.30687E-02	8.07691E-09	-5.30687E-02
8.0000	0.00000E+00	1.09182E-01	1.70681E-08	-1.09182E-01
12.0000	0.00000E+00	1.63648E-01	2.70646E-08	-1.63648E-01
16.0000	-1.49415E-08	2.06561E-01	2.32314E-08	-2.06561E-01
20.0000	-2.83057E-08	2.42673E-01	5.05213E-08	-2.42673E-01
24.0000	-3.36869E-08	2.77978E-01	9.79532E-08	-2.77978E-01
28.0000	-6.00104E-08	3.10986E-01	1.19611E-07	-3.10986E-01

Figure 46 Panel Bending Moment Partial Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
FIN SET 1 PANEL HINGE MOMENTS (ABOUT HINGE LINE)

CASE 1
PAGE 20

FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
2.36					3.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

ANGLE OF ATTACK, DEG.	PANEL 1	PANEL 2	PANEL 3	PANEL 4
0.0000	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4.0000	0.00000E+00	-5.58607E-02	-8.50186E-09	5.58607E-02
8.0000	0.00000E+00	-1.14926E-01	-1.79661E-08	1.14926E-01
12.0000	0.00000E+00	-1.72258E-01	-2.84885E-08	1.72258E-01
16.0000	1.57276E-08	-2.17429E-01	-2.44537E-08	2.17429E-01
20.0000	2.97949E-08	-2.55441E-01	-5.31793E-08	2.55441E-01
24.0000	3.54592E-08	-2.92603E-01	-1.03107E-07	2.92603E-01
28.0000	6.31677E-08	-3.27347E-01	-1.25904E-07	3.27347E-01

Figure 47 Panel Hinge Moment Partial Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
UNTRIMMED STATIC AERODYNAMIC COEFFICIENTS

CASE 1
PAGE 2

FLIGHT CONDITIONS								REFERENCE DIMENSIONS				
MACH NUMBER	ALTITUDE	VELOCITY	PRESSURE	TEMPERATURE	REYNOLDS NUMBER	SIDESLIP ANGLE	ROLL ANGLE	REF. AREA	REF. LENGTH LONG.	REF. LENGTH LAT.	MOMENT REF. CENTER LONG.	MOMENT REF. CENTER VERTICAL
	FT	FT/SEC	LB/IN**2	DEG R	1/FT	DEG	DEG	IN**2	IN	IN	IN	IN
0.60					1.000E+06	0.00	0.00	11.045	3.750	3.750	18.750	0.000

TABLE OF UNTRIMMED NORMAL FORCE COEFFICIENTS

PANEL DEFLECTION ANGLE, DEG.

ALPHA	-25.0000	-20.0000	-15.0000	-10.0000	-5.0000	0.0000	5.0000	10.0000	15.0000	20.0000
0.00	-1.0150	-0.9025	-0.7207	-0.4950	-0.2471	0.0000	0.2471	0.4950	0.7207	0.9025
8.00	1.9098	2.3005	2.6479	2.9346	3.1942	3.4112	3.6550	3.8627	4.0093	4.0666
16.00	4.6103	5.1425	5.7523	6.3950	7.0090	7.5348	7.9105	8.0954	8.0628	7.7300

NOMINAL DEFLECTION ANGLES (DEGREES)

FIN SET	FIN 1	FIN 2	FIN 3	FIN 4
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00

PANELS IN FIN SET 1 HAVE BEEN DEFLECTED

Figure 48 Untrimmed Partial Output

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
BODY ALONE PRESSURE OUTPUT

CASE 1
PAGE 6

MACH = 2.36 ANGLE OF ATTACK = 0.00 DEG.

PRESSURE COEFFICIENTS

X/DMAX	CP	M-LOCAL
0.000000	0.284442	1.867502
0.050000	0.276666	1.876899
0.100000	0.268558	1.886836
0.150000	0.260664	1.896649
0.200000	0.252793	1.906577
0.250000	0.244998	1.916553
0.300000	0.237277	1.926579
0.350000	0.229629	1.936659
0.400000	0.222055	1.946791
0.450000	0.214555	1.956977
0.500000	0.207422	1.966809
0.550000	0.200348	1.976703
0.600000	0.193339	1.986654
⋮	⋮	⋮
9.000000	-0.001058	2.348805
9.050000	-0.001027	2.348726
9.100000	-0.000996	2.348649
9.150001	-0.000966	2.348574
9.200000	-0.000937	2.348501
9.250000	-0.000909	2.348431
9.300000	-0.000881	2.348362
9.350000	-0.000855	2.348296
9.400001	-0.000829	2.348232
9.450000	-0.000804	2.348170
9.500000	-0.000780	2.348109
9.550000	-0.000757	2.348050
9.600000	-0.000734	2.347993
9.650001	-0.000712	2.347938
9.700000	-0.000691	2.347885
9.750000	-0.000670	2.347833
9.800000	-0.000650	2.347783
9.850000	-0.000630	2.347734
9.900001	-0.000611	2.347687
9.950000	-0.000593	2.347641
10.000000	-0.000575	2.347596

Figure 49 Body Pressure Distribution from SOSE, AOA=0°

THE USAF AUTOMATED MISSILE DATCOM * REV 4/91 *
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
BODY ALONE PRESSURE OUTPUT

CASE 1
PAGE 7

MACH = 2.36 ANGLE OF ATTACK = 4.00 DEG.

PRESSURE COEFFICIENTS

X/DMAX	PHI=0	PHI=30	PHI=60	PHI=90	PHI=120	PHI=150	PHI=180
0.000000	0.205017	0.213251	0.238086	0.277548	0.323402	0.361022	0.375649
0.050000	0.198498	0.206561	0.230935	0.269780	0.315035	0.352226	0.366698
0.100000	0.191601	0.199509	0.223454	0.261705	0.306353	0.343094	0.357399
0.150000	0.184943	0.192688	0.216191	0.253836	0.297876	0.334171	0.348313
0.200000	0.178321	0.185902	0.208957	0.245988	0.289413	0.325258	0.339235
0.250000	0.171782	0.179199	0.201802	0.238216	0.281024	0.316416	0.330227
0.300000	0.165323	0.172574	0.194724	0.230518	0.272706	0.307643	0.321287
0.350000	0.158942	0.166027	0.187721	0.222893	0.264458	0.298938	0.312415
0.400000	0.152640	0.159557	0.180795	0.215342	0.256280	0.290301	0.303610
0.450000	0.146416	0.153166	0.173945	0.207864	0.248173	0.281733	0.294873
0.500000	0.140527	0.147113	0.167444	0.200751	0.240449	0.273562	0.286538
0.550000	0.134699	0.141121	0.161004	0.193699	0.232784	0.265447	0.278259
0.600000	0.128937	0.135194	0.154629	0.186710	0.225180	0.257393	0.270039
0.650000	0.123244	0.129338	0.148323	0.179790	0.217643	0.249402	0.261882
0.700000	0.117622	0.123551	0.142088	0.172938	0.210172	0.241476	0.253789
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
9.250000	0.006124	0.002622	-0.004344	-0.007705	-0.003958	0.003291	0.006897
9.300000	0.006164	0.002660	-0.004312	-0.007678	-0.003937	0.003309	0.006913
9.350000	0.006203	0.002696	-0.004280	-0.007653	-0.003916	0.003326	0.006930
9.400001	0.006240	0.002732	-0.004249	-0.007628	-0.003897	0.003343	0.006946
9.450000	0.006277	0.002767	-0.004219	-0.007604	-0.003877	0.003359	0.006961
9.500000	0.006312	0.002800	-0.004191	-0.007581	-0.003859	0.003375	0.006976
9.550000	0.006347	0.002833	-0.004163	-0.007558	-0.003841	0.003390	0.006990
9.600000	0.006380	0.002865	-0.004135	-0.007536	-0.003823	0.003405	0.007004
9.650001	0.006412	0.002895	-0.004109	-0.007515	-0.003806	0.003420	0.007018
9.700000	0.006443	0.002925	-0.004083	-0.007495	-0.003790	0.003434	0.007031
9.750000	0.006474	0.002954	-0.004059	-0.007474	-0.003774	0.003447	0.007044
9.800000	0.006503	0.002982	-0.004035	-0.007455	-0.003758	0.003460	0.0070[illegible]
9.850000	0.006532	0.003009	-0.004011	-0.007436	-0.003743	0.003473	0.007068
9.900001	0.006560	0.003035	-0.003989	-0.007418	-0.003729	0.003485	0.007080
9.950000	0.006587	0.003061	-0.003967	-0.007400	-0.003714	0.003497	0.007091
10.000000	0.006613	0.003085	-0.003945	-0.007383	-0.003701	0.003509	0.007102

NOTE - PHI= 0 IS TOP VERTICAL CENTER (LEEWARD)
PHI=180 IS BOTTOM VERTICAL CENTER (WINDWARD)

Figure 50 Body Pressure Distribution at Angle of Attack

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THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *                    CASE  1
AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS                     PAGE 10
PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
PRESSURE COEFFICIENTS ON FIN SET 1 AT MACH = 2.360

FOR ALPHA = 0.0

LOCAL CHORD =    0.5798 FT

Y/(B/2)          X/C          CP
0.0003          0.0000       0.3413
0.0003          0.0000       0.3310
0.0003          0.0001       0.3013
0.0003          0.0003       0.2559
0.0003          0.0005       0.2003
0.0003          0.0008       0.1410
0.0003          0.0011       0.0853
0.0003          0.0014       0.0399
0.0003          0.0023       0.0229
0.0003          0.0025       0.0200
0.0003          0.0026       0.0173
0.0003          0.0028       0.0148
0.0003          0.0029       0.0124
0.0003          0.0031       0.0103
0.0003          0.0032       0.0052
0.0003          0.0034      -0.0052
   .               .            .
   .               .            .
   .               .            .
0.0003          0.5020      -0.0049
0.0003          0.5326      -0.0049
0.0003          0.5631      -0.0049
0.0003          0.5937      -0.0049
0.0003          0.6243      -0.0049
0.0003          0.6549      -0.0049
0.0003          0.6854      -0.0049
0.0003          0.7160      -0.0814
0.0003          0.7160      -0.0814
0.0003          0.7444      -0.0682
0.0003          0.7728      -0.0682
0.0003          0.8012      -0.0682
0.0003          0.8296      -0.0682
0.0003          0.8580      -0.0682
0.0003          0.8864      -0.0682
0.0003          0.9148      -0.0682
0.0003          0.9432      -0.0682
0.0003          0.9716      -0.0682
0.0003          1.0000       0.0055
```

Figure 51 Fin Pressure Distribution Output

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                         THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *                                     CASE  1
                         AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS                                      PAGE  3
                         PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
                              BODY + 2 FIN SETS DYNAMIC DERIVATIVES

 ------------------------------- FLIGHT CONDITIONS ------------------------------   ------------- REFERENCE DIMENSIONS ------------
  MACH    ALTITUDE   VELOCITY   PRESSURE  TEMPERATURE  REYNOLDS   SIDESLIP   ROLL      REF.      REF. LENGTH      MOMENT REF. CENTER
 NUMBER                                                 NUMBER     ANGLE    ANGLE     AREA    LONG.     LAT.      LONG.     VERTICAL
             FT       FT/SEC    LB/IN**2     DEG R       1/FT       DEG      DEG     IN**2     IN        IN        IN         IN
  2.36                                                3.000E+06     0.00     0.00   11.045    3.750     3.750    18.750      0.000

                     -------------------- DYNAMIC DERIVATIVES (PER DEGREE) --------------------
                      ALPHA           CNQ             CMAD               CMQ+CMAD

                        0.0         6.984E-01       3.641E-01          -3.83418E+00
                        4.0         8.745E-01       6.338E-01          -4.53844E+00
                        8.0         1.168E+00       1.101E+00          -5.62797E+00
                       12.0         1.492E+00       1.606E+00          -6.77794E+00
                       16.0         1.727E+00       1.946E+00          -7.59595E+00
```

Figure 52 Dynamic Derivative Output

```
                    THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *                                   CASE  1
                    AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS                                    PAGE  3
                    PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
                      EXTRAPOLATION SUMMARY FOR INPUT MACH  1

-------------------- ROUTINE TRACE-BACK --------------------   LOWER BOUNDS        UPPER BOUNDS        FINAL RESULT

MISDAT  AERO  ASECT  MAXCL  MVLOOK  LNTRP                      X= 3.0000000E+06    X= 2.5000000E+07    X= 1.1600000E+06
                                                               Y=-3.2997910E-02    Y= 4.3997213E-02    Y=-5.3236630E-02

MISDAT  AERO  ASECT  MAXCL  MVLOOK  LNTRP                      X= 3.0000000E+06    X= 2.5000000E+07    X= 1.0859260E+06
                                                               Y=-3.1011123E-02    Y= 4.1348159E-02    Y=-5.0796986E-02

MISDAT  AERO  BODY   BODYA  STBODY  BODYCN  BDCNAN  MVLOOK     X= 8.0000001E-01    X= 1.0000000E+00    X= 1.1000000E+00
                                            LNTRP              Y= 4.4000001E+00    Y= 5.9000001E+00    Y= 5.5000005E+00

MISDAT  AERO  BODY   BODYA  STBODY  BODYCN  BDCNAN  MVLOOK     X= 8.0000001E-01    X= 1.0000000E+00    X= 1.1000000E+00
                                            LNTRP              Y= 7.7500000E+00    Y= 8.0500002E+00    Y= 7.7500010E+00

MISDAT  AERO  BODY   BODYA  STBODY  BODYCN  BDCNAN  MVLOOK     X= 8.0000001E-01    X= 1.0000000E+00    X= 1.1000000E+00
                                            LNTRP              Y= 1.0450000E+01    Y= 1.0600000E+01    Y= 1.0400002E+01

MISDAT  AERO  BODY   BODYA  STBODY  BODYCM  BDXCPN  MVLOOK     X= 8.0000001E-01    X= 1.0000000E+00    X= 1.1000000E+00
                                            LNTRP              Y= 5.8000002E+00    Y= 4.9499998E+00    Y= 3.5499992E+00

MISDAT  AERO  BODY   BODYA  STBODY  BODYCM  BDXCPN  MVLOOK     X= 8.0000001E-01    X= 1.0000000E+00    X= 1.1000000E+00
                                            LNTRP              Y= 8.5000000E+00    Y= 7.9000001E+00    Y= 6.0999999E+00

MISDAT  AERO  BODY   BODYA  STBODY  BODYCM  BDXCPN  MVLOOK     X= 8.0000001E-01    X= 1.0000000E+00    X= 1.1000000E+00
                                            LNTRP              Y= 1.1650000E+01    Y= 1.1500000E+01    Y= 1.0900000E+01

MISDAT  AERO  FINS   FINCN  FCNAA   FCNAAT  FCNAAS  FCLMSB     X= 0.0000000E+00    X= 6.0000000E+01    X= 6.3434952E+01
                                            MVLOOK  LNTRP      Y= 8.9999998E-01    Y= 1.3000000E+00    Y= 1.3343494E+00

MISDAT  AERO  FINS   FINCN  FCNAA   FCNAAT  FCNAAS  FCLMSB     X= 0.0000000E+00    X= 6.0000000E+01    X= 6.3434952E+01
                                            MVLOOK  LNTRP      Y= 8.9999998E-01    Y= 1.1900001E+00    Y= 1.2174797E+00

MISDAT  AERO  FINS   FINCN  FCNAA   FCNAAT  FCNAAS  FCLMSB     X= 0.0000000E+00    X= 6.0000000E+01    X= 6.3434952E+01
                                            MVLOOK  LNTRP      Y= 8.9999998E-01    Y= 1.0300000E+00    Y= 1.0437398E+00

MISDAT  AERO  FINS   FINCN  FCNAA   FCNAAT  FCNAAS  FCLMSB     X= 0.0000000E+00    X= 6.0000000E+01    X= 6.3434952E+01
                                            MVLOOK  LNTRP      Y= 8.9999998E-01    Y= 8.7000000E-01    Y= 8.6656505E-01

MISDAT  AERO  FINS   FINCN  FCNAA   FCNAAT  FCNAAS  FCLMSB     X= 0.0000000E+00    X= 6.0000000E+01    X= 6.3434952E+01
                                            MVLOOK  LNTRP      Y= 8.9999998E-01    Y= 7.3000002E-01    Y= 7.1282530E-01

MISDAT  AERO  FINS   FINCN  FCNAA   FCNAAT  FCNAAS  FCLMSB     X= 0.0000000E+00    X= 6.0000000E+01    X= 6.3434952E+01
                                            MVLOOK  LNTRP      Y= 8.9999998E-01    Y= 5.8999997E-01    Y= 5.4878056E-01
```

Figure 53 Extrapolation Message Output

```
DUMP OF INTERNAL DATA ARRAYS IN FOOT-POUND-RANKINE UNITS

FLT(  1)= 5.00000E+00  FLT(  2)= 0.00000E+00  FLT(  3)= 4.00000E+00  FLT(  4)= 8.00000E+00  FLT(  5)= 1.20000E+01
FLT(  6)= 1.60000E+01  FLT(  7)= 1.00000E-30  FLT(  8)= 1.00000E-30  FLT(  9)= 1.00000E-30  FLT( 10)= 1.00000E-30
FLT( 11)= 1.00000E-30  FLT( 12)= 1.00000E-30  FLT( 13)= 1.00000E-30  FLT( 14)= 1.00000E-30  FLT( 15)= 1.00000E-30
FLT( 16)= 1.00000E-30  FLT( 17)= 1.00000E-30  FLT( 18)= 1.00000E-30  FLT( 19)= 1.00000E-30  FLT( 20)= 1.00000E-30
FLT( 21)= 1.00000E-30  FLT( 22)= 0.00000E+00  FLT( 23)= 0.00000E+00  FLT( 24)= 1.00000E+00  FLT( 25)= 2.36000E+00
FLT( 26)= 1.00000E-30  FLT( 27)= 1.00000E-30  FLT( 28)= 1.00000E-30  FLT( 29)= 1.00000E-30  FLT( 30)= 1.00000E-30
FLT( 31)= 1.00000E-30  FLT( 32)= 1.00000E-30  FLT( 33)= 1.00000E-30  FLT( 34)= 1.00000E-30  FLT( 35)= 1.00000E-30
FLT( 36)= 1.00000E-30  FLT( 37)= 1.00000E-30  FLT( 38)= 1.00000E-30  FLT( 39)= 1.00000E-30  FLT( 40)= 1.00000E-30
FLT( 41)= 1.00000E-30  FLT( 42)= 1.00000E-30  FLT( 43)= 1.00000E-30  FLT( 44)= 1.00000E-30  FLT( 45)= 1.00000E-30
FLT( 46)= 3.00000E+06  FLT( 47)= 1.00000E-30  FLT( 48)= 1.00000E-30  FLT( 49)= 1.00000E-30  FLT( 50)= 1.00000E-30
FLT( 51)= 1.00000E-30  FLT( 52)= 1.00000E-30  FLT( 53)= 1.00000E-30  FLT( 54)= 1.00000E-30  FLT( 55)= 1.00000E-30
FLT( 56)= 1.00000E-30  FLT( 57)= 1.00000E-30  FLT( 58)= 1.00000E-30  FLT( 59)= 1.00000E-30  FLT( 60)= 1.00000E-30
FLT( 61)= 1.00000E-30  FLT( 62)= 1.00000E-30  FLT( 63)= 1.00000E-30  FLT( 64)= 1.00000E-30  FLT( 65)= 1.00000E-30
FLT( 66)= 1.00000E-30  FLT( 67)= 1.00000E-30  FLT( 68)= 1.00000E-30  FLT( 69)= 1.00000E-30  FLT( 70)= 1.00000E-30
FLT( 71)= 1.00000E-30  FLT( 72)= 1.00000E-30  FLT( 73)= 1.00000E-30  FLT( 74)= 1.00000E-30  FLT( 75)= 1.00000E-30
FLT( 76)= 1.00000E-30  FLT( 77)= 1.00000E-30  FLT( 78)= 1.00000E-30  FLT( 79)= 1.00000E-30  FLT( 80)= 1.00000E-30
FLT( 81)= 1.00000E-30  FLT( 82)= 1.00000E-30  FLT( 83)= 1.00000E-30  FLT( 84)= 1.00000E-30  FLT( 85)= 1.00000E-30
FLT( 86)= 1.00000E-30  FLT( 87)= 1.00000E-30  FLT( 88)= 1.00000E-30  FLT( 89)= 1.00000E-30  FLT( 90)= 1.00000E-30
FLT( 91)= 1.00000E-30  FLT( 92)= 1.00000E-30  FLT( 93)= 1.00000E-30  FLT( 94)= 1.00000E-30  FLT( 95)= 1.00000E-30
FLT( 96)= 1.00000E-30  FLT( 97)= 1.00000E-30  FLT( 98)= 1.00000E-30  FLT( 99)= 1.00000E-30  FLT(100)= 1.00000E-30
FLT(101)= 1.00000E-30  FLT(102)= 1.00000E-30  FLT(103)= 1.00000E-30  FLT(104)= 1.00000E-30  FLT(105)= 1.00000E-30
FLT(106)= 1.00000E-30  FLT(107)= 1.00000E-30  FLT(108)= 1.00000E-30  FLT(109)= 1.00000E-30  FLT(110)= 1.00000E-30
FLT(111)= 1.00000E-30  FLT(112)= 1.00000E-30  FLT(113)= 1.00000E-30  FLT(114)= 1.00000E-30  FLT(115)= 1.00000E-30
FLT(116)= 1.00000E-30  FLT(117)= 1.00000E-30  FLT(118)= 1.00000E-30  FLT(119)= 1.00000E-30  FLT(120)= 1.00000E-30
FLT(121)= 1.00000E-30  FLT(122)= 1.00000E-30  FLT(123)= 1.00000E-30  FLT(124)= 1.00000E-30  FLT(125)= 1.00000E-30

REFQ(  1)= 7.66990E-02  REFQ(  2)= 3.12500E-01  REFQ(  3)= 3.12500E-01  REFQ(  4)= 0.00000E+00  REFQ(  5)= 1.56250E+00
REFQ(  6)= 0.00000E+00  REFQ(  7)= 1.00000E+00  REFQ(  8)= 0.00000E+00  REFQ(  9)= 1.00000E-30
```

Figure 54 Internal Array Dump Output

5.0 IMPLEMENTATION GUIDE

This section details the steps necessary to make the code operational on the user's computer system. In addition this section contains cross reference tables for all the subroutines and common blocks used in the computer program. It also contains a description of the variables in the common blocks that can be written out using the WRITE or DUMP cards in the input deck.

5.1 INSTALLATION ON COMPUTER SYSTEMS

This section details the steps necessary to make the computer code functional on the user's computer system. Although conversion of the program can be easily accomplished by someone with a good understanding of the FORTRAN V language, it is highly recommended that someone familiar with the computer operating system be consulted.

5.1.1 Requirements

In order for the Missile Datcom code to be successfully implemented on the user's computer system, there are three requirements which must be met, as follows:

- Language - As received, the CDC code is compatible with FORTRAN IV, except as noted below. The program can be easily converted to FORTRAN V and the changes required are described later in this section. The VAX compatible code is maintained as a FORTRAN V version.

- Namelist - The code has been designed with an internal FORTRAN NAMELIST emulator to allow the input and output (I/O) to be handled by namelist variables. This is an exception to Standard FORTRAN but with the emulator as part of the code the program will run under Standard FORTRAN. The code is not easily converted to fixed field, rather than namelist input.

- I/O Scratch Files - The code uses the following logical file units: 1, 2, 3, 4, 5, 6 and 7. All file units are accessed using formatted reads and writes. File units 1, 2, 4 and 7 are used internally; file units 3, 5 and 6 transfer data between the user and the code.

5.1.2 Coding Changes

In order for the code to made operational on other computer systems, several minor coding changes may be required.

- Namelist Delimiter - The namelist delimiter used on the computer system is set in the routine BLOCK DATA. It is preset to the "$" character for VAX computers in the DATA statement defining the variable KAND. It must be changed for other computers, which employ the "&" character for the namelist delimiter.

- Defining UNUSED - The variable UNUSED is defined in routine BLOCK DATA. It is preset to "1.E-30" and should be acceptable for most computers. If this number is too small for the computer being used, it may be changed to a small, non-zero, positive number which is no larger than 1×10^{-10}. This constant is used to initialize all program data arrays. If a new value is assigned it must also be incorporated in NMLIST, variable JUNSD.

5.1.3 Input/Output

Seven file units are used by the program. They are the logical units 1, 2, 3, 4, 5, 6 and 7 which are used as follows:

Unit	Usage
1	All input cards read from unit 5 are written to unit 1 by CONERR after they have been checked for errors
2	Namelists for the input "case" are read from unit 1 and written to unit 2 by READIN. The namelists for the "case" are read from unit 2.
3	Data dumped at user request (using PLOT or WRITE control cards) are written to unit 3 by PLOT3, PLTTRM, and/or SAVEF. The PLOT file format is given in Appendix B.
4	Method extrapolation messages are printed in compact form on unit 4 by MESSG and read by EXTRAP.
5	User inputs are read from unit 5 by CONERR.
6	Program output is written to unit 6.
7	The FORMAT and WRITE control cards are written to unit 7 by CONTRL and read by SAVEF.

The method extrapolation messages are written to unit 4 as they are generated if a PRINT EXTRAP control card is present. When the aerodynamic calculations are completed for each Mach number, the line END MACH is written to signify the end of messages for that Mach number. For each extrapolation two lines are written to unit 4 as follows:

Line	Contents
1	The names of the routines called to get to this part of the code. The last name is the routine currently being executed.
2	The seven (7) parameters defining the extrapolation: First Value: Value for the independent variable Second Value: Final Result Third Value: Lower independent value Fourth Value: Upper independent value Fifth Value: Lower dependent value Sixth Value: Upper dependent value Seventh Value: Order of extrapolation

The data is automatically read and formatted for output by the program in the standard output file. Hence, this file need not be retained or printed by the user at the end of code execution.

5.2 PROGRAM CROSS REFERENCES

This section summarizes the cross references of subroutines and common blocks within the code. The tables given can be used to verify the proper location of common blocks within the code, identify the subroutines called by each of the methods and, if program revisions are made, facilitates subroutine modification. The cross references are given by subroutine name and by common block name.

5.2.1 Subroutine Cross Reference By Name

Figures 55 and 56 summarizes the subroutine cross references for the program. Figure 55 lists each subroutine and gives the subroutines that call it. Figure 56 list each subroutine and gives the subroutines which it calls. For convenience, the subroutines are listed in alphabetical order.

5.2.2 Common Block Cross Reference By Name

Figures 57 and 58 summarize the common blocks used by the program. Seven types of common blocks are used by the program: (1) Internal data management, (2) Input data, (3) Aerodynamic work, (4) Geometry, (5) Static aerodynamic, (6) Dynamic aerodynamic, and (7) Trim blocks. These common blocks are shown in Figure 59 for each type of data. For each block type, the data is subdivided by task or configuration, as appropriate.

Internal Data Management : These eight common blocks contain the data to control program execution.

CASEID - Contains the case title (from the CASEID control card), the case number and flag to print extrapolation messages and the flag to suppress calculation of the lateral-directional derivatives.

THERY - Contains the flags necessary to select the correct supersonic body theory.

CONST - Contains the program constants.

TRACE - Contains the position in the code being executed.

LOGIC - Contains the configuration and program option flags.

DUMPF - Contains the logic flags to delete namelist inputs using the DELETE control card.

INPCON - Contains the data required to validate namelist name inputs.

Input Common Blocks: Except for namelist EXPR, each input namelist is assigned a separate common block for data storage. The values read in from EXPR are stored in the common blocks in which the coefficients of the partial configurations for which the experimental data is provided are stored. The theoretical values are over written by the experimental data.

Common Block	Namelist
FLC	FLTCON
REFQN	REFQ
ABODIN	AXIBOD
ABODIN	ELLBOD
FSET1	FINSET1
FSET2	FINSET2
FSET3	FINSET3
FSET4	FINSET4
DESIG	FINSET1 - FINSET4(NACA control card)
INCID	DEFLCT
TRIMIN	TRIM

Aerodynamic Work Arrays: These common blocks contain most of the intermediate aerodynamic calculations, particularly those needed for other methods.

Common Block	Configuration Component
BDWORK	Body
F1WORK	Fin Set 1
F2WORK	Fin Set 2
F3WORK	Fin Set 3
F4WORK	Fin Set 4

Geometry Common Blocks: These common blocks hold the results of the geometric calculations for each component of the configuration.

Common Block	Configuration Component
GEOBOD	Body
GEOFS1	Fin Set 1
GEOFS2	Fin Set 2
GEOFS3	Fin Set 3
GEOFS4	Fin Set 4

Static Aerodynamic Results: The final static aerodynamic results are stored by configuration or configuration component. These arrays form the Ideal Output Matrix (I.O.M.), where the data is stored in a fixed format, regardless of configuration component. These data are exactly that which is printed as the normal aerodynamic output. Twenty array elements are reserved for each aerodynamic parameter, which corresponds to the 20 angles of attack. Eleven aerodynamic coefficients are defined. this pattern is used for both the static (SBODY, SFIN1, SFIN2,SFIN3, SFIN4, SB1, SB12, SB123, SB1234) and dynamic (DBODY, DFIN1, DFIN2, DFIN3, DFIN4, DB1, DB12, DB123, BD1234) aerodynamic results. Since a maximum of four sets of fins are permitted, SB1 (and DB1) refers to the body plus the most forward fin set, SB12 (and DB12) refers to the body plus the first and second most forward fin sets, SB123 (and DB123) refers to the body plus the three most forward fin sets, Finally, SB1234 (and DB1234) refers to the body plus all four fin sets.

Trim Results: The code uses ten deflection angles, as a function of angle of attack, in order to interpolate for the longitudinal trim points. The untrimmed aerodynamic results obtained are stored in the common blocks UTRIMD as a function of angle of attack and deflection angle. the aerodynamic coefficients retained are C_N, C_m, C_A, C_Y, C_n, and C_l. The trimmed results are stored in the common block TRIMD, and are the trimmed values for C_N, C_A, C_Y, C_n, and C_l.

Experimental Data Substitution: Experimental substitution allows the user to input experimental data for any part of the configuration or any partial configuration. For example the user may input body alone experimental data, fin alone experimental data and/or body + one (1) fin set experimental data for a configuration having a body + two (2) sets of fins. The experimental is substituted into the appropriate common block and replaces the computed theoretical coefficients. The substituted coefficients are then used in the configuration synthesis process in subroutine SYNTHS.

Configuration Incrementing: Configuration incrementing requires all cases of an incrementing run to have the same configuration components (i.e. if the first case is a body + one (1) fin set then all the cases that follow must be for a body + one (1) fin set). Configuration incrementing runs must be thought of as a sequence of case runs rather than individual cases. When the first case is executed, the experimental data is substituted for the configuration being run. The experimental data is then compared with the theoretical coefficients. The correction factors that are computed are stored in the INC common block. When the subsequent cases are run, the correction factors are applied to the theoretical coefficients in SYNTHS. These corrections are made prior to printing out the aerodynamic results.

Module	Calls Module(s):
AERO	ADDECG ASECT BETADR BODY CAINC CMINC CNINC CSLINC CSNINC CYINC DAMP DUMPRT ETRACE FINS FLAPS FLTCDS ILTARO INZIOM POLINT PRINT STRACE SUBEXP TRIMIT
AFTCAP	CP3DW
AIRFOL	COORD1 COORD4 COORD5 COORD6 CORD4M CORD5M CORDSP DECODE ETRACE HEADER LNTRP STRACE SUPXY
ALPBET	
ALPEQ	CLVR DIHED ETRACE SPLINE STRACE
ANGDET	
ARCCA	CP3DW SIMPW
ARCOR	TABLOK
ARSECH	
ASECT	CLMAX ETRACE STRACE THEORY
ASOSL	AXZU
ATMOS	
AXBNDY	ARSECH
AXINWT	
AXZU	
BASPRS	BOTCA BOTCNM CKDAT ETRACE STRACE TABLOK
BDAMP	BCNAD BODVAR BQDER BSUB ETRACE HYPER LMSC SPIN83 STRACE
BDCAB	ETRACE LNTRP STRACE
BDCALP	
BDCAP1	ETRACE MVLOOK STRACE
BDCAP2	ETRACE MVLOOK STRACE
BDCAPR	
BDCAMC	ETRACE LNTRP STRACE

Module	Calls Module(s):
BDCAWF	ETRACE MVLOOK STRACE
BDCAWN	ETRACE INTER4 STRACE
BDCDRV	BDCAP1 BDCAP2 ETRACE STRACE
BDCMP	
BDCMV	
BDCNAB	ETRACE LNTRP STRACE
BDCNAF	ETRACE LNTRP STRACE
BDCNAN	ETRACE LNTRP MVLOOK STRACE
BDCNP	
BDCNV	
BDPART	HEADER PRIFLC
BDXCPB	
BDXCPN	ETRACE LNTRP MVLOOK STRACE
BETADR	[illegible] BLKLDD ETRACE STRACE SYNTHS
BETAU	
BITSS	ELLIP1 ELLIP2 ETRACE LNTRP STRACE
BLUNT	LOOP
BLUNTN	
BODCFD	ILTCDC
BODNWT	
BODVAR	
BODY	BODYA BODYE ETRACE STRACE
BODYA	ALPBET BDPART ETRACE POLINT STBODY STRACE SUPBOD
BODYCA	BDCAB BDCALP BDCAPR BDCAWF BDCAWN BDCDRV CAFRIC CDPRES CDPROT ETRACE HEADER LNTRP MDIV PRIFLC STRACE
BODYCM	BDCMP BDCMV BDXCPB BDXCPF BDXCPN ETRACE STRACE

Figure 55 Subroutine Cross Reference (Listed by Calling Routine)

Module	Calls Module(s):					
BODYCN	BDCNAB ETRACE	BDCNAF GETETA	BDCNAN STRACE	BDCNP	BDCNV	CDCS
BODYE	ALPBET POLINT	BDPART STRACE	BODYA	ETRACE	GETCNO	LNTRP
BOTCA	ETRACE	STRACE	TABLOK			
BOTCNM	BDCNAB	ETRACE	STRACE			
BSUB						
BUILD	CIRC	CYL	FLAT			
CAFRIC	SKINF					
CAINC	CALIB	ETRACE	LNTRP	STRACE		
CALIB	ETRACE	LNTRP	STRACE			
CARRYO	CARRYS	ETRACE	FALCP	FWDXAC	STRACE	
CARRYS						
CCARD	DELNMS	NMTEST				
CDCS	ETRACE	LNTRP	MVLOOK	STRACE		
CDPRES	EVAL	FRCOR	SPLIN2			
CDPROT	BUILD STREAM	CIRC	CONVRT	CYL	FLAT	LUGSHO
CHKEND						
CIRC	CROSS	CUBIC				
CLMAX	ETRACE	LNTRP	MVLOOK	STRACE		
CLOCD						
CLVR	ETRACE	LNTRP	STRACE	SVRINT		
CMINC	CALIB	ETRACE	LNTRP	STRACE		
CNEWT						
CNINC	CALIB	ETRACE	LNTRP	STRACE		
CNNEWT	ETRACE	LNTRP	STRACE			

Module	Calls Module(s):					
CNPAXI						
CNPTWO						
CNSBT						
CONEP						
CONERR	CCARD	HEADER	INSBLK	NMLIST	NMTEST	PACK
CONIC	DSPLAN	DSWET	DVOL	DXCENP	DXCENV	SPHERE
CONTRL	DELNMS	NMTEST				
CONVRT						
COORD1	SLEQ					
COORD4						
COORD5						
COORD6	SLEQ					
CORD4M	SLEQ					
CORD5M	SLEQ					
CORDSP						
CP3DW						
CPCAL	SRATIO					
CPDIST						
CROSS	TABLOK					
CSLINC	CALIB	ETRACE	LNTRP	STRACE		
CSNINC	CALIB	ETRACE	LNTRP	POLINT	STRACE	
CUBIC						
CVRBOD	CONVRT					
CVRFIN	CONVRT					
CVRFLT	CONVRT					
CVRREF	CONVRT					

Figure 55 Subroutine Cross Reference (Listed by Calling Routine) - Continued

Module	Calls Module(s):					
CVRTFT	CVRBOD	CVRFIN	CVRFLT	CVRREF		
CVRTUS	CVRBOD	CVRFIN	CVRFLT	CVRREF		
CYINC	CALIB	ETRACE	LNTRP	POLINT	STRACE	
CYL	ARCOR	CROSS	CUBIC			
CYPAXI						
DAMP	BDAMP	DDSYN	ETRACE	FDAMP	INZDYN	STRACE
DDSYN	POLINT					
DELMMS	MMTEST					
DELV	AXBNDY	DISC2	JAS26			
DISC2	INTERP					
DIVCFD	ILTCDC					
DIVNWT						
DMPARY						
DREAD	RARBOD RINLET	RAXIS RREFQ	RDEFL RTRIM	RELLB	RFIN1	RFLT
DSPLAN						
DSWET						
DSWETE	DXCENP	ELLIP2				
DUMPRT	DMPARY					
DVOL						
DVOLE						
DWRITE	HEADER	PRIFLC				
DXCENP						
DXCENV						
DXCNVE						
ELLIP1						

Module	Calls Module(s):					
ELLIP2						
ELLKWB						
EQN44						
EXPAND						
EXTRAP	HEADER					
F1GEOM	ASPECT YMGC	FINCEN	FINMGC	FINPLN	SWEEPN	TCEFFT
F2GEOM	ASPECT YMGC	FINCEN	FINMGC	FINPLN	SWEEPN	TCEFFT
F3GEOM	ASPECT YMGC	FINCEN	FINMGC	FINPLN	SWEEPN	TCEFFT
F4GEOM	ASPECT YMGC	FINCEN	FINMGC	FINPLN	SWEEPN	TCEFFT
FALCP	ETRACE	MVLOOK	STRACE			
FAPART	HEADER	PRIFLC				
FCALE						
FCALP	ETRACE	LNTRP	STRACE			
FCAWPF	AFTCAP SIMPW	ARCCA	ASOSL	HEADER	HEXCA	HSOSL
FCAWS						
FCAWT	ETRACE	MVLOOK	STRACE			
FCLMSB	ETRACE	LNTRP	MVLOOK	STRACE		
FCLMSH	ETRACE	MVLOOK	STRACE			
FCNA	ETRACE	FCNASB	FCNASP	FCNATR	STRACE	
FCNAA	ETRACE	FCNAAH	FCNAAS	FCNAAT	STRACE	
FCNAAH	ETRACE	FIG60B	FSDETA	LNTRP	MVLOOK	STRACE
FCNAAS	ETRACE	FCLMSB	FCLMSH	LNTRP	MVLOOK	STRACE
FCNAAT	ETRACE	FCNAAH	FCNAAS	FCNASB	FCNASP	STRACE
FCNASB						

Figure 55 Subroutine Cross Reference (Listed by Calling Routine) - Continued

Module	Calls Module(s):
FCNASP	ETRACE, LNTRP, LUCERO, MVLOOK, STRACE
FCNATR	ETRACE, LOOK3, STRACE
FDAMP	BITSS, ETRACE, FINVAR, LAM025, SBLAMO, SFCMAD, SFCMQ, SFCNAD, SFCNQ, SSADER, SSQDER, STRACE, SUBDER, TRANS
FDP5	FD5
FGEOM	AIRFOL, ETRACE, F1GEOM, F2GEOM, F3GEOM, F4GEOM, FOIL, LNTRP, STRACE, USEFOL
FIG60B	ETRACE, LNTRP, MVLOOK, STRACE
FINCA	ETRACE, FINXCA, STRACE
FINCAB	ETRACE, LNTRP, STRACE
FINCAP	
FINCEN	ASPECT
FINCM	ETRACE, FALCP, FMPART, FWDXAC, LNTRP, STRACE
FINCN	ETRACE, FCNA, FCNAA, FNPART, LNTRP, SPLN2, STRACE
FINDVN	
FINFIN	BETAU, ETRACE, SPLINE, STRACE
FINS	ETRACE, FINCA, FINCM, FINCN, FNPART, POLINT, STRACE
FINVAR	POLINT
FINXCA	ETRACE, FAPART, FCALE, FCALP, FCAMPF, FCAMS, FCAMT, FINCAB, FINCAP, LNTRP, SKINF, STRACE
FIT	
FLAPS	CUBIC, MVLOOK
FLAT	CROSS, CUBIC, PLATE
FLTCDS	ALPBET, ATMOS
FMPART	HEADER, PRIFLC
FNPART	HEADER, PRIFLC

Module	Calls Module(s):
FOIL	ETRACE, LNTRP, STRACE, TOHOLL
FORINT	
FORLOG	
FORREA	
FSDETA	ANGDET
FWDXAC	ETRACE, MVLOOK, STRACE
GEO	
GEOAXI	CONIC, CVRTFT, CVRTUS, ETRACE, HAACK, OGIVE, POWR, PRIAXI, STRACE, USERS
GEOELL	CONIC, CVRTFT, CVRTUS, DSPLAN, DSWET, DSWETE, DVOL, DVOLE, DXCNVE, ETRACE, HAACK, LNTRP, OGIVE, POWR, PRIELL, STRACE, USEREL
GEOFIN	ETRACE, FGEOM, PRIFIN, STRACE
GEOINL	BODNWT, DIVNWT, ILTANG, ILTFR, ILTNWT, ILTVIN, INLETG
GEOM	CVRTUS, ETRACE, GEOAXI, GEOELL, GEOFIN, GEOINL, LNTRP, STRACE
GETCNO	CNNEWT, CNSBT, ETRACE, LNTRP, QUAD1, STRACE
GETETA	ETRACE, LNTRP, STRACE
GETNLN	
HAACK	DSPLAN, DSWET, DVOL, DXCENP, DXCENV, SPHERE
HEADER	
HEXCA	CP3DW, NDIV, SIMPW
HINGEM	HEADER, PRIFLC
HSOSL	HXZU
HXZU	
HYBG1	FDP5, INTERP, LOOP
HYBG2	BLUNT, FDP5, INTERP

Figure 55 Subroutine Cross Reference (Listed by Calling Routine) - Continued

Module	Calls Module(s):
HYBRID	HYBG1 HYBG2 HYBINZ HYBSET VANDYK
HYBSET	FDP5 LOOP
HYPER	
HYPERS	ETRACE HEADER NEWTON QUAD1 SPLINE STRACE
IAD2D	MVLOOK
IADAXI	MVLOOK
IDEAL	ETRACE LNTRP POLINT STRACE
ILTARO	BDCAPR CAFRIC CDPRES DVOL IAD2D IADAXI ILTRVX ILTSWT ILTVIS INLETA LINFOR LINXCP MDIV MOMFOR POTAR1 POTAR2 POTAR3 SKINF
ILTCDC	
ILTCFD	AXINWT ILTCDC
ILTNWT	
ILTRVX	
ILTSWT	
ILTVIN	
ILTVIS	BODCFD DIVCFD ILTCFD
INITZ	INZBOD INZFIN INZFLC INZFLG INZIOM INZREF INZTRM
INLETA	HEADER PRIFLC
INLETG	CVRTFT CVRTUS HEADER
INTER4	ETRACE LNTRP STRACE
INTERP	INTERS
JAS26	ARSECH
KWBALP	ETRACE LNTRP STRACE
LAM025	BITSS ETRACE SBLAMO SFCMAD SFCMQ SFCNAD SFCNQ STRACE
LINFOR	

Module	Calls Module(s):
LINXCP	
LMSC	CNEWT LNSTAR LOOK STANR
LNSTAR	
LNTRP	ETRACE MESSG STRACE
LOADF	
LOOK1	INDEXS
LOOK2	INDEXS LOOK1
LOOK3	INDEXS LOOK2
LUCERO	
LUGSHO	FLAT
LVALUE	NMTEST
MAJERR	SORT
MATCHX	
MDIV	
MESSG	
MISDAT	AERO BLOCKD CONERR EXTRAP GEOM INITZ READIN STRACE
MOMFOR	
MVLOOK	ETRACE LNTRP STRACE
NAMER	EXTRST FINDCH FINDVN READCD REPTCT SKIPBL SUBINT SUBLOG SUBREA TODEC TOINT TOLOG
NAMEW	FORINT FORLOG FORREA
NEWT	
NEWTON	
NMLIST	CHKEND SUBNAM SUBNM2 TESTOR
NMTEST	
OGIVE	DSPLAN DSWET DVOL DXCENP DXCENV SPHERE

Figure 55 Subroutine Cross Reference (Listed by Calling Routine) - Continued

Module	Calls Module(s):					
PANLCN	ALPEQ	ETRACE	FINFIN	SPLINE	STRACE	YCP
PLATE	TABLOK					
PLOT3	CVRTFT	CVRTUS				
PLTTRM	CVRTFT	CVRTUS				
POLINT						
POTAR1	CNPTWO	CYPDIV	CYPTWO			
POTAR2	CNPTWO	CYPDIV	CYPTWO			
POTAR3	CNPAXI	CYPAXI	CYPDIV			
POWR	DSPLAN	DSWET	DVOL	DXCENP	DXCENV	SPHERE
PRIAXI	HEADER					
PRIELL	HEADER					
PRIF1						
PRIF2						
PRIF3						
PRIF4						
PRIFIN	CVRTFT	CVRTUS	HEADER	PRIF1	PRIF2	PRIF3
	PRIF4					
PRIFLC	CVRTFT	CVRTUS	SWRITE			
PRIIOM	CLOCD	PLOT3	PRIFLC	SWRITE		
PRINT	DWRITE	PRINTS	SAVEF			
PRINTS	HEADER	PRIIOM				
PRITRM	CLOCD	HEADER	PRIFLC	SWRITE		
PRIUNT	HEADER	PRIFLC				
QUAD1						
RARBOD	NAMER					
RAXIS	NAMER					
RDEFL	NAMER					

Module	Calls Module(s):					
READCD						
READIN	CONTRL	GETNLN	HEADER	MAJERR	READNL	WRITNL
READNL	DREAD	RARBOD	RAXIS	RDEFL	RELLB	RFINS
	RFLT	RINLET	RREFQ	RTRIM		
RELLB	NAMER					
REPTCT	EXTRST	FINDCH	TOINT			
REXPR	NAMER					
RFIN1	NAMER					
RFIN2	NAMER					
RFIN3	NAMER					
RFIN4	NAMER					
RFINS	RFIN1	RFIN2	RFIN3	RFIN4		
RFLT	NAMER					
RINLET	NAMER					
RREFQ	NAMER					
RTRIM	NAMER					
SAVEF	DDECOD					
SBLAMO	ELLIP2	ETRACE	LNTRP	STRACE		
SETGEO	BLUNTN	PARAB				
SFCHAD						
SFCHQ						
SFCNAD						
SFCNQ						
SFWRW	ETRACE	FIT	MVLOOK	STRACE		
SHOCK						
SIMP	INTERP					

Figure 55 Subroutine Cross Reference (Listed by Calling Routine) - Continued

Module	Calls Module(s):
SKINF	
SLEQ	
SLOPE	ETRACE STRACE
SORT	
SOSE	CONEP CPDIST EQN44 EXPAND GEO HEADER LOADF MATCHX QUAD1 SETGEO SHOCK WEDGE
SPHERE	
SPIN83	ETRACE LNTRP STRACE
SPLINE	ETRACE MESSG STRACE
SRATIO	
SSADER	ETRACE MVLOOK STRACE
SSCMQ	
SSQDER	SSCMQ
STANR	
STBODY	BODYCA BODYCM BODYCN ETRACE STRACE
STREAM	CROSS CUBIC
SUBDER	ETRACE LNTRP STRACE
SUBEXP	CONVRT ETRACE LNTRP POLINT REXPR STRACE
SUBNAM	
SUBNM2	
SUMPOT	ARSECH DISC2 JAS26
SUPBOD	BASPRS BDCAB BDCMP BDCMV BDCNP BDCNV CAFRIC CDCS CDPROT ETRACE HEADER PRIFLC STRACE SUPPOT
SUPPOT	ETRACE HYBRID HYPERS SOSE STRACE
SUPXY	
SVRINT	
SVTRAK	

Module	Calls Module(s):
SWEEPN	ASPECT
SWRITE	
SYNPAR	HEADER PRIFLC
SYNTHS	ADDECG CAINC CARRYO CMINC CNINC CSLINC CSNINC CYINC DIHED ELLKWB ETRACE HINGEM XWBALP LNTRP PANLCN POLINT SFWRW SPLINE STRACE SUBEXP SVTRAK SYNPAR VRINTS
TABLOK	ETRACE MESSG STRACE
TCEFFT	
TESTOR	LVALUE NMTEST RVALUE VNAME
THEORY	ETRACE HEADER IDEAL SLOPE STRACE
TODEC	
TOHOLL	
TOINT	FINDCH TODEC
TOLOG	SKIPBL
TRANS	BITSS ETRACE LAM025 SBLAMO SFCMAD SFCMQ SFCNAD SFCNQ SSADER SSQDER STRACE SUBDER
TRIMIT	BLKLDD DUMPRT ETRACE LNTRP PLTTRM PRITRM PRIUNT STRACE SYNTHS
USEFOL	ETRACE LNTRP POLINT STRACE
USEREL	CONIC DSPLAN DSWET DSWETE DVOLE DXCENP DXCNVE
USERS	CONIC DSPLAN DSWET DVOL DXCENP DXCENV ETRACE LNTRP STRACE
VANDYK	ARSECH DELV HEADER NEWT SUMPOT WAVE
VNAME	NMTEST
VRINTS	
WARBOD	NAMEW
WAVE	SIMP

Figure 55 Subroutine Cross Reference (Listed by Calling Routine) - Continued

Module	Calls Module(s):					
WEDGE						
WELLB	NAMEW					
WINLET	NAMEW					
WRAXIS	NAMEW					
WRDEFL	NAMEW					
WRFIN1	NAMEW					
WRFIN2	NAMEW					
WRFIN3	NAMEW					
WRFIN4	NAMEW					
WRFLT	NAMEW					
WRITNL	WARBOD	WELLB	WINLET	WRAXIS	WRDEFL	WRFIN1
	WRFIN2	WRFIN3	WRFIN4	WRFLT	WRREFQ	WRTRIM
WRREFQ	NAMEW					
WRTRIM	NAMEW					
YBAR	ETRACE	MVLOOK	STRACE			
YCP	ETRACE	STRACE	YBAR			
YMGC	FINMGC					

Module	Calls Module(s):

Figure 55 Subroutine Cross Reference (Listed by Calling Routine) - Continued

Module	Called by Module(s):					
ADDZCG	AERO	SYNTHS				
AERO	MISDAT					
AFTCAP	FCAMPF					
AIRFOL	FGEOM					
ALPBET	BETADR	BODYA	BODYE	FLTCDS		
ALPEQ	PANLCN					
ANGDET	FSDETA					
ARCCA	FCAMPF					
ARCOR	CYL					
ARSECH	AXBNDY	JAS26	SUMPOT	VANDYK		
ASECT	AERO					
ASOSL	FCAMPF					
ASPECT	F1GEOM	F2GEOM	F3GEOM	F4GEOM	FINCEN	SWEEPN
ATMOS	FLTCDS					
AXBNDY	DELV					
AXINWT	ILTCFD					
AXZU	ASOSL					
BASPRS	SUPBOD					
BCNAD	BDAMP					
BDAMP	DAMP					
BDCAB	BODYCA	SUPBOD				
BDCALP	BODYCA					
BDCAP1	BDCDRV					
BDCAP2	BDCDRV					
BDCAPR	BODYCA	ILTARO				
BDCAWC						

Module	Called by Module(s):		
BDCAWF	BODYCA		
BDCAWN	BODYCA		
BDCDRV	BODYCA		
BDCMP	BODYCM	SUPBOD	
BDCMV	BODYCM	SUPBOD	
BDCNAB	BODYCN	BOTCNM	
BDCNAF	BODYCN		
BDCNAN	BODYCN		
BDCNP	BODYCN	SUPBOD	
BDCNV	BODYCN	SUPBOD	
BDPART	BODYA	BODYE	
BDXCPB	BODYCM		
BDXCPF	BODYCM		
BDXCPN	BODYCM		
BETADR	AERO		
BETAU	FINFIN		
BITSS	FDAMP	LAM025	TRANS
BLKLDD	BETADR	TRIMIT	
BLOCKD	MISDAT		
BLUNT	HYBG2		
BLUNTN	SETGEO		
BODCFD	ILTVIS		
BODNWT	GEOINL		
BODVAR	BDAMP		
BODY	AERO		
BODYA	BODY	BODYE	

Figure 56 Subroutine Cross Reference (Listed by Routine that is Called)

Module	Called by Module(s):					
BODYCA	STBODY					
BODYCM	STBODY					
BODYCN	STBODY					
BODYE	BODY					
BOTCA	BASPRS					
BOTCNM	BASPRS					
BQDER	BDAMP					
BSUB	BDAMP					
BUILD	CDPROT					
CAFRIC	BODYCA	ILTARO	SUPBOD			
CAINC	AERO	SYNTHS				
CALIB	CAINC	CMINC	CNINC	CSLINC	CSNINC	CYINC
CARRYO	SYNTHS					
CARRYS	CARRYO					
CCARD	CONERR					
CDCS	BODYCN	SUPBOD				
CDPRES	BODYCA	ILTARO				
CDPROT	BODYCA	SUPBOD				
CHKEND	NMLIST					
CIRC	BUILD	CDPROT				
CKDAT	BASPRS					
CLMAX	ASECT					
CLOCD	PRIIOM	PRITRM				
CLVR	ALPEQ					
CMINC	AERO	SYNTHS				
CNEWT	LMSC					

Module	Called by Module(s):					
CNINC	AERO	SYNTHS				
CNNEWT	GETCNO					
CNPAXI	POTAR3					
CNPTWO	POTAR1	POTAR2				
CNSBT	GETCNO					
CONEP	SOSE					
CONERR	MISDAT					
CONIC	GEOAXI	GEOELL	USEREL	USERS		
CONTRL	READIN					
CONVRT	CDPROT	CVRBOD	CVRFIN	CVRFLT	CVRREF	SUBEXP
COORD1	AIRFOL					
COORD4	AIRFOL					
COORD5	AIRFOL					
COORD6	AIRFOL					
CORD4M	AIRFOL					
CORD5M	AIRFOL					
CORDSP	AIRFOL					
CP3DM	AFTCAP	ARCCA	HEXCA			
CPCAL						
CPDIST	SOSE					
CROSS	CIRC	CYL	FLAT	STREAM		
CSLINC	AERO	SYNTHS				
CSNINC	AERO	SYNTHS				
CUBIC	CIRC	CYL	FLAPS	FLAT	STREAM	
CVRBOD	CVRTFT	CVRTUS				
CVRFIN	CVRTFT	CVRTUS				

Figure 56 Subroutine Cross Reference (Listed by Routine that is Called) - Continued

Module	Called by Module(s):					
CVRFLT	CVRTFT	CVRTUS				
CVRREF	CVRTFT	CVRTUS				
CVRTFT	GEOAXI	GEOELL	INLETG	PLOT3	PLTTRM	PRIFIN
	PRIFLC					
CVRTUS	GEOAXI	GEOELL	GEOM	INLETG	PLOT3	PLTTRM
	PRIFIN	PRIFLC				
CYINC	AERO	SYNTHS				
CYL	BUILD	CDPROT				
CYPAXI	POTAR3					
CYPDIV	POTAR1	POTAR2	POTAR3			
CYPTWO	POTAR1	POTAR2				
DAMP	AERO					
DDECOD	SAVEF					
DDSYN	DAMP					
DECODE	AIRFOL					
DELNMS	CCARD	CONTRL				
DELV	VANDYK					
DIHED	ALPEQ	SYNTHS				
DISC2	DELV	SUMPOT				
DIVCFD	ILTVIS					
DIVNWT	GEOINL					
DMPARY	DUMPRT					
DREAD	READNL					
DSPLAN	CONIC	GEOELL	HAACK	OGIVE	POWR	USEREL
	USERS					
DSWET	CONIC	GEOELL	HAACK	OGIVE	POWR	USEREL
	USERS					
DSWETE	GEOELL	USEREL				

Module	Called by Module(s):					
DUMPRT	AERO	TRIMIT				
DVOL	CONIC	GEOELL	HAACK	ILTARO	OGIVE	POWR
	USERS					
DVOLE	GEOELL	USEREL				
DWRITE	PRINT					
DXCENP	CONIC	DSWETE	HAACK	OGIVE	POWR	USEREL
	USERS					
DXCENV	CONIC	HAACK	OGIVE	POWR	USERS	
DXCNVE	GEOELL	USEREL				
ELLIP1	BITSS					
ELLIP2	BITSS	DSWETE	SBLAMO			
ELLKWB	SYNTHS					
EQN44	SOSE					
ETRACE	AERO	AIRFOL	ALPEQ	ASECT	BASPRS	BDAMP
	BDCAB	BDCAP1	BDCAP2	BDCAWC	BDCAWF	BDCAWN
	BDCDRV	BDCNAB	BDCNAF	BDCNAN	BDXCPN	BETADR
	BITSS	BODY	BODYA	BODYCA	BODYCM	BODYCN
	BODYE	BOTCA	BOTCNM	CAINC	CALIB	CARRYO
	CDCS	CLMAX	CLVR	CMINC	CNINC	CNNEWT
	CSLINC	CSNINC	CYINC	DAMP	FALCP	FCALP
	FCAWT	FCLMSB	FCLMSH	FCNA	FCNAA	FCNAAH
	FCNAAS	FCNAAT	FCNASP	FCNATR	FDAMP	FGEOM
	FIG60B	FINCA	FINCAB	FINCM	FINCN	FINFIN
	FINS	FINXCA	FOIL	FWDXAC	GEOAXI	GEOELL
	GEOFIN	GEOM	GETCNO	GETETA	HYPERS	IDEAL
	INTER4	KWBALP	LAM025	LNTRP	MVLOOK	PANLCN
	SBLAMO	SFWRW	SLOPE	SPIN83	SPLINE	SSADER
	STBODY	SUBDER	SUBEXP	SUPBOD	SUPPOT	SYNTHS
	TABLOK	THEORY	TRANS	TRIMIT	USEFOL	USERS
	YBAR	YCP				
EVAL	CDPRES					
EXPAND	SOSE					
EXTRAP	MISDAT					
EXTRST	NAMER	REPTCT				
F1GEOM	FGEOM					

Figure 56 Subroutine Cross Reference (Listed by Routine that is Called) - Continued

Module	Called by Module(s):		
F2GEOM	FGEOM		
F3GEOM	FGEOM		
F4GEOM	FGEOM		
FALCP	CARRYO	FINCM	
FAPART	FINXCA		
FCALE	FINXCA		
FCALP	FINXCA		
FCAWPF	FINXCA		
FCAWS	FINXCA		
FCAWT	FINXCA		
FCLMSB	FCNAAS		
FCLMSH	FCNAAS		
FCNA	FINCN		
FCNAA	FINCN		
FCNAAH	FCNAA	FCNAAT	
FCNAAS	FCNAA	FCNAAT	
FCNAAT	FCNAA		
FCNASB	FCNA	FCNAAT	
FCNASP	FCNA	FCNAAT	
FCNATR	FCNA		
FD5	FDP5		
FDAMP	DAMP		
FDP5	HYBG1	HYBG2	HYBSET
FGEOM	GEOFIN		
FIG60B	FCNAAH		
FINCA	FINS		

Module	Called by Module(s):				
FINCAB	FINXCA				
FINCAP	FINXCA				
FINCEN	F1GEOM	F2GEOM	F3GEOM	F4GEOM	
FINCM	FINS				
FINCN	FINS				
FINDCH	NAMER	REPTCT	TOINT		
FINDVN	NAMER				
FINFIN	PANLCN				
FINMGC	F1GEOM	F2GEOM	F3GEOM	F4GEOM	YMGC
FINPLN	F1GEOM	F2GEOM	F3GEOM	F4GEOM	
FINS	AERO				
FINVAR	FDAMP				
FINXCA	FINCA				
FIT	SFWRW				
FLAPS	AERO				
FLAT	BUILD	CDPROT	LUGSHO		
FLTCDS	AERO				
FMPART	FINCM				
FNPART	FINCN	FINS			
FOIL	FGEOM				
FORINT	NAMEW				
FORLOG	NAMEW				
FORREA	NAMEW				
FRCOR	CDPRES				
FSDETA	FCNAAH				
FWDXAC	CARRYO	FINCM			

Figure 56 Subroutine Cross Reference (Listed by Routine that is Called) - Continued

Module	Called by Module(s):
GEO	SOSE
GEOAXI	GEOM
GEOELL	GEOM
GEOFIN	GEOM
GEOINL	GEOM
GEOM	MISDAT
GETCNO	BODYE
GETETA	BODYCN
GETNLN	READIN
HAACK	GEOAXI GEOELL
HEADER	AIRFOL BDPART BODYCA CONERR DWRITE EXTRAP FAPART FCAMPF FMPART FNPART HINGEM HYPERS INLETA INLETG PRIAXI PRIELL PRIFIN PRINTS PRITRM PRIUNT READIN SOSE SUPBOD SYNPAR THEORY VANDYK
HEXCA	FCAMPF
HINGEM	SYNTHS
HSOSL	FCAMPF
HXZU	HSOSL
HYBG1	HYBRID
HYBG2	HYBRID
HYBINZ	HYBRID
HYBRID	SUPPOT
HYBSET	HYBRID
HYPER	BDAMP
HYPERS	SUPPOT
IAD2D	ILTARO
IADAXI	ILTARO

Module	Called by Module(s):
IDEAL	THEORY
ILTANG	GEOINL
ILTARO	AERO
ILTCDC	BODCFD DIVCFD ILTCFD
ILTCFD	ILTVIS
ILTFR	GEOINL
ILTNWT	GEOINL
ILTRVX	ILTARO
ILTSWT	ILTARO
ILTVIN	GEOINL
ILTVIS	ILTARO
INDEXS	LOOK1 LOOK2 LOOK3
INITZ	MISDAT
INLETA	ILTARO
INLETG	GEOINL
INSBLK	CONERR
INTER4	BDCAWN
INTER5	INTERP
INTERP	DISC2 HYBG1 HYBG2 SIMP
INZBOD	INITZ
INZDYN	DAMP
INZFIN	INITZ
INZFLC	INITZ
INZFLG	INITZ
INZIOM	AERO INITZ
INZREF	INITZ

Figure 56 Subroutine Cross Reference (Listed by Routine that is Called) - Continued

Module	Called by Module(s):					
IN2TRM	INIT2					
JAS26	DELV	SUMPOT				
KWBALP	SYNTHS					
LAM025	FDAMP	TRANS				
LINFOR	ILTARO					
LINXCP	ILTARO					
LIPCOR						
LMSC	BDAMP					
LNSTAR	LMSC					
LNTRP	AIRFOL	BDCAB	BDCAWC	BDCNAB	BDCNAF	BDCNAN
	BDXCPN	BITSS	BODYCA	BODYE	CAINC	CALIB
	CDCS	CLMAX	CLVR	CMINC	CNINC	CNNEWT
	CSLINC	CSNINC	CYINC	FCALP	FCLMSB	FCNAAH
	FCNAAS	FCNASP	FGEOM	FIG60B	FINCAB	FINCM
	FINCN	FINXCA	FOIL	GEOELL	GEOM	GETCNO
	GETETA	IDEAL	INTER4	KWBALP	MVLOOK	SBLAMO
	SPIN83	SUBDER	SUBEXP	SYNTHS	TRIMIT	USEFOL
	USERS					
LOADF	SOSE					
LOOK	LMSC					
LOOK1	LOOK2					
LOOK2	LOOK3					
LOOK3	FCNATR					
LOOP	BLUNT	HYBG1	HYBSET			
LUCERO	FCNASP					
LUGSHO	CDPROT					
LVALUE	TESTOR					
MAJERR	READIN					
MATCHX	SOSE					
MDIV	BODYCA	ILTARO				

Module	Called by Module(s):					
MESSG	LNTRP	SPLINE	TABLOK			
MISDAT						
MOMFOR	ILTARO					
MVLOOK	BDCAP1	BDCAP2	BDCAWF	BDCNAN	BDXCPN	CDCS
	CLMAX	FALCP	FCAWT	FCLMSB	FCLMSH	FCNAAH
	FCNAAS	FCNASP	FIG60B	FLAPS	FWDXAC	IAD2D
	IADAXI	SFWRW	SSADER	YBAR		
NAMER	RARBOD	RAXIS	RDEFL	RELLB	REXPR	RFIN1
	RFIN2	RFIN3	RFIN4	RFLT	RINLET	RREFQ
	RTRIM					
NAMEW	WARBOD	WELLB	WINLET	WRAXIS	WRDEFL	WRFIN1
	WRFIN2	WRFIN3	WRFIN4	WRFLT	WRREFQ	WRTRIM
NDIV	HEXCA					
NEWT	VANDYK					
NEWTON	HYPERS					
NMLIST	CONERR					
NMTEST	CCARD	CONERR	CONTRL	DELNMS	LVALUE	TESTOR
	VNAME					
OGIVE	GEOAXI	GEOELL				
PACK	CONERR					
PANLCN	SYNTHS					
PARAB	SETGEO					
PLATE	FLAT					
PLOT3	PRIIOM					
PLTTRM	TRIMIT					
POLINT	AERO	BODYA	BODYE	CSNINC	CYINC	DDSYN
	FINS	FINVAR	IDEAL	SUBEXP	SYNTHS	USEFOL
POTAR1	ILTARO					
POTAR2	ILTARO					
POTAR3	ILTARO					

Figure 56 Subroutine Cross Reference (Listed by Routine that is Called) - Continued

Module	Called by Module(s):
POWR	GEOAXI GEOELL
PRIAXI	GEOAXI
PRIELL	GEOELL
PRIF1	PRIFIN
PRIF2	PRIFIN
PRIF3	PRIFIN
PRIF4	PRIFIN
PRIFIN	GEOFIN
PRIFLC	BDPART BODYCA DWRITE FAPART FMPART FNPART HINGEM INLETA PRIIOM PRITRM PRIUNT SUPBOD SYNPAR
PRIIOM	PRINTS
PRINT	AERO
PRINTS	PRINT
PRITRM	TRIMIT
PRIUNT	TRIMIT
QUAD1	GETCNO HYPERS SOSE
RARBOD	DREAD READNL
RAXIS	DREAD READNL
RDEFL	DREAD READNL
READCD	NAMER
READIN	MISDAT
READNL	READIN
RELLB	DREAD READNL
REPTCT	NAMER
REXPR	SUBEXP
RFIN1	DREAD RFINS

Module	Called by Module(s):
RFIN2	RFINS
RFIN3	RFINS
RFIN4	RFINS
RFINS	READNL
RFLT	DREAD READNL
RINLET	DREAD READNL
RREFQ	DREAD READNL
RTRIM	DREAD READNL
RVALUE	TESTOR
SAVEF	PRINT
SBLAMO	FDAMP LAM025 TRANS
SETGEO	SOSE
SFCMAD	FDAMP LAM025 TRANS
SFCMQ	FDAMP LAM025 TRANS
SFCNAD	FDAMP LAM025 TRANS
SFCNQ	FDAMP LAM025 TRANS
SFWRW	SYNTHS
SHOCK	SOSE
SIMP	WAVE
SIMPW	ARCCA FCAWPF HEXCA
SKINF	CAFRIC FINXCA ILTARO
SKIPBL	NAMER TOLOG
SLEQ	COORD1 COORD6 CORD4M CORD5M
SLOPE	THEORY
SORT	MAJERR
SOSE	SUPPOT

Figure 56 Subroutine Cross Reference (Listed by Routine that is Called) - Continued

Module	Called by Module(s):					
SPHERE	CONIC	HAACK	OGIVE	POWR		
SPIN83	BDAMP					
SPLIN2	CDPRES					
SPLINE	ALPEQ	FINFIN	HYPERS	PANLCN	SYNTHS	
SPLN2	FINCN					
SRATIO	CPCAL					
SSADER	FDAMP	TRANS				
SSCMQ	SSQDER					
SSQDER	FDAMP	TRANS				
STANR	LMSC					
STBODY	BODYA					
STRACE	AERO	AIRFOL	ALPEQ	ASECT	BASPRS	BDAMP
	BDCAB	BDCAP1	BDCAP2	BDCAWC	BDCAWF	BDCAWN
	BDCDRV	BDCNAB	BDCNAF	BDCNAN	BDXCPN	BETADR
	BITSS	BODY	BODYA	BODYCA	BODYCM	BODYCN
	BODYE	BOTCA	BOTCNM	CAINC	CALIB	CARRYO
	CDCS	CLMAX	CLVR	CMINC	CNINC	CNNEWT
	CSLINC	CSNINC	CYINC	DAMP	FALCP	FCALP
	FCAWT	FCLMSB	FCLMSH	FCNA	FCNAA	FCNAAH
	FCNAAS	FCNAAT	FCNASP	FCNATR	FDAMP	FGEOM
	FIG60B	FINCA	FINCAB	FINCM	FINCN	FINFIN
	FINS	FINXCA	FOIL	FWDXAC	GEOAXI	GEOELL
	GEOFIN	GEOM	GETCNO	GETETA	HYPERS	IDEAL
	INTER4	KWBALP	LAM025	LNTRP	MISDAT	MVLOOK
	PANLCN	SBLAMO	SFWRW	SLOPE	SPIN83	SPLINE
	SSADER	STBODY	SUBDER	SUBEXP	SUPBOD	SUPPOT
	SYNTHS	TABLOK	THEORY	TRANS	TRIMIT	USEFOL
	USERS	YBAR	YCP			
STREAM	CDPROT					
SUBDER	FDAMP	TRANS				
SUBEXP	AERO	SYNTHS				
SUBINT	NAMER					
SUBLOG	NAMER					
SUBNAM	NMLIST					

Module	Called by Module(s):				
SUBNM2	NMLIST				
SUBREA	NAMER				
SUMPOT	VANDYK				
SUPBOD	BODYA				
SUPPOT	SUPBOD				
SUPXY	AIRFOL				
SVRINT	CLVR				
SVTRAK	SYNTHS				
SWEEPN	F1GEOM	F2GEOM	F3GEOM	F4GEOM	
SWRITE	PRIFLC	PRIIOM	PRITRM		
SYNPAR	SYNTHS				
SYNTHS	BETADR	TRIMIT			
TABLOK	ARCOR	BASPRS	BOTCA	CROSS	PLATE
TCEFFT	F1GEOM	F2GEOM	F3GEOM	F4GEOM	
TESTOR	NMLIST				
THEORY	ASECT				
TODEC	NAMER	TOINT			
TOHOLL	FOIL				
TOINT	NAMER	REPTCT			
TOLOG	NAMER				
TRANS	FDAMP				
TRIMIT	AERO				
USEFOL	FGEOM				
USEREL	GEOELL				
USERS	GEOAXI				
VANDYK	HYBRID				

Figure 56 Subroutine Cross Reference (Listed by Routine that is Called) - Continued

Module	Called by Module(s):				Module	Called by Module(s):
VNAME	TESTOR					
VRINTS	SYNTHS					
WARBOD	WRITNL					
WAVE	VANDYK					
WEDGE	SOSE					
WELLB	WRITNL					
WINLET	WRITNL					
WRAXIS	WRITNL					
WRDEFL	WRITNL					
WRFIN1	WRITNL					
WRFIN2	WRITNL					
WRFIN3	WRITNL					
WRFIN4	WRITNL					
WRFLT	WRITNL					
WRITNL	READIN					
WRREFQ	WRITNL					
WRTRIM	WRITNL					
YBAR	YCP					
YCP	PANLCN					
YMGC	F1GEOM	F2GEOM	F3GEOM	F4GEOM		

Figure 56 Subroutine Cross Reference (Listed by Routine that is Called) - Continued

Common Block	Used by Module(s):					
ABODIN	AERO	BDPART	BODYA	BODYCA	BODYCM	BODYCN
	BODYE	CDPROT	CVRBOD	DAMP	DUMPRT	FINCM
	GEOAXI	GEOELL	GEOM	HYBSET	ILTARO	INZBOD
	MAJERR	MISDAT	PRIAXI	PRIELL	READNL	SAVEF
	SUPBOD	SUPPOT	SYNTHS	USEREL	USERS	WARBOD
	WELLB	WRAXIS				
ASMVAR	ASECT	IDEAL	MISDAT	SLOPE	THEORY	
BDWORK	AERO	BDPART	BODYA	BODYCA	BODYCM	BODYCN
	BODYE	DUMPRT	INZIOM	MISDAT	SAVEF	SUPBOD
	SYNTHS					
BITS	BITSS	INZDYN	SFCMAD	SFCMQ	SFCNAD	SFCNQ
BODVSC	AXINWT	BODCFD	BODNWT	CNPAXI	CNPTWO	CYPAXI
	CYPDIV	CYPTWO	DIVCFD	DIVNWT	GEOINL	ILTANG
	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT	ILTRVX
	ILTSWT	ILTVIN	ILTVIS	LINFOR	LINXCP	MOMFOR
	POTAR1	POTAR2	POTAR3			
CAFD	AFTCAP	ARCCA	ASOSL	CP3DW	FCAWPF	HEXCA
	HSOSL					
CASEID	AERO	BETADR	CONTRL	HEADER	INZFLG	MESSG
	MISDAT	PLOT3	PLTTRM	PRIIOM	READIN	SAVEF
	SYNTHS	TRIMIT				
CFFLOW	AXINWT	BODCFD	BODNWT	CNPAXI	CNPTWO	CYPAXI
	CYPDIV	CYPTWO	DIVCFD	DIVNWT	GEOINL	ILTANG
	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT	ILTRVX
	ILTSWT	ILTVIN	ILTVIS	LINFOR	LINXCP	MOMFOR
	POTAR1	POTAR2	POTAR3			
CKDATA	CKDAT					
CONST	ADDZCG	AERO	ALPBET	ALPEQ	ASECT	ASOSL
	AXINWT	AXZU	BDCAB	BDCALP	BDCAWF	BDCMP
	BDCMV	BDCNAF	BDCNP	BDCNV	BDPART	BDXCPB
	BETADR	BETAU	BLKLDD	BLOCKD	BLUNT	BODCFD
	BODNWT	BODYA	BODYCA	BODYCM	BODYCN	BODYE
	CAFRIC	CAINC	CARRYO	CARRYS	CCARD	CDCS
	CDPRES	CLMAX	CLOCD	CLVR	CMINC	CNINC
	CNNEWT	CNPAXI	CNPTWO	CNSBT	CONERR	CONIC
	CONVRT	COORD1	COORD6	CORD4M	CORDSP	CP3DW
	CPDIST	CSLINC	CSNINC	CVRFLT	CYINC	CYPAXI
	CYPDIV	CYPTWO	DAMP	DDSYN	DISC2	DIVCFD
	DIVNWT	DSPLAN	DSWET	DSWETE	DUMPRT	DVOL
	DVOLE	DXCENP	DXCENV	DXCNVE	F1GEOM	F2GEOM
	F3GEOM	F4GEOM	FALCP	FCALE	FCALP	FCAWPF
	FCAWS	FCAWT	FCLMSB	FCLMSH	FCNA	FCNAAH
	FCNAAS	FCNAAT	FCNASB	FCNASP	FCNATR	FGEOM
	FIG60B	FINCEN	FINCM	FINCN	FINFIN	FINS
	FINXCA	FLAPS	FLTCDS	FNPART	FOIL	FSDETA
	FWDXAC	GEOAXI	GEOELL	GEOFIN	GEOINL	GEOM
	GETCNO	GETNLN	HAACK	HINGEM	HSOSL	HXZU
	HYBINZ	HYBSET	HYPERS	IAD2D	IADAXI	IDEAL
	ILTANG	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT
	ILTRVX	ILTSWT	ILTVIN	ILTVIS	INZBOD	INZDYN
	INZFIN	INZFLC	INZFLG	INZIOM	INZREF	INZTRM
	LINFOR	LINXCP	LMSC	LVALUE	MAJERR	MOMFOR
	NEWT	NEWTON	NMLIST	OGIVE	PACK	PANLCN
	PLOT3	PLTTRM	POTAR1	POTAR2	POTAR3	POWR
	PRIAXI	PRIELL	PRIF1	PRIF2	PRIF3	PRIF4
	PRIFLC	PRIIOM	PRINTS	PRITRM	RARBOD	RAXIS
	RDEFL	RELLB	REXPR	RFIN1	RFIN2	RFIN3
	RFIN4	RFLT	RINLET	RREFQ	RTRIM	RVALUE
	SAVEF	SFWRW	SLOPE	SOSE	SPHERE	SUBEXP
	SUPBOD	SUPPOT	SVTRAK	SWEEPN	SWRITE	SYNTHS
	TESTOR	THEORY	TRIMIT	USEFOL	USEREL	USERS
	VANDYK	VRINTS	WARBOD	WAVE	WEDGE	WELLB
	WINLET	WRAXIS	WRDEFL	WRFIN1	WRFIN2	WRFIN3
	WRFIN4	WRFLT	WRREFQ	WRTRIM		
DB1	DDSYN	DUMPRT	DWRITE	INZIOM	MISDAT	SAVEF
DB12	DDSYN	DUMPRT	DWRITE	INZIOM	MISDAT	SAVEF
DB123	DDSYN	DUMPRT	DWRITE	INZIOM	MISDAT	SAVEF
DB1234	DDSYN	DUMPRT	DWRITE	INZIOM	MISDAT	SAVEF
DBODY	DDSYN	DUMPRT	DWRITE	INZIOM	MISDAT	SAVEF
	SPIN83					
DDFIN1	DDSYN	DUMPRT	DWRITE	INZIOM	MISDAT	
DDFIN2	DDSYN	DUMPRT	DWRITE	INZIOM	MISDAT	
DDFIN3	DDSYN	DUMPRT	DWRITE	INZIOM	MISDAT	
DDFIN4	DDSYN	DUMPRT	DWRITE	INZIOM	MISDAT	
DERIV	CNEWT	INZDYN	LMSC	LNSTAR	STANR	
DESIG	ASECT	CONTRL	FGEOM	INZFIN	INZFLG	MISDAT
	SAVEF					
DFIN1	SAVEF					
DFIN2	SAVEF					
DFIN3	SAVEF					

Figure 57 Common Block/Subroutine Cross Reference (Listed by Common Block)

Common Block	Used by Module(s):					
DFIN4	SAVEF					
DFLAGS	CONTRL	DELNMS	INZFLG	MISDAT	READIN	SAVEF
DIVVSC	AXINWT	BODCFD	BODNWT	CNPAXI	CNPTWO	CYPAXI
	CYPDIV	CYPTWO	DIVCFD	DIVNWT	GEOINL	ILTANG
	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT	ILTRVX
	ILTSWT	ILTVIN	ILTVIS	LINFOR	LINXCP	MOMFOR
	POTAR1	POTAR2	POTAR3			
DUMPF	CONTRL	DUMPRT	INZFLG	MISDAT	SAVEF	
F1WORK	AERO	ASECT	DAMP	DUMPRT	FGEOM	FINCA
	FINCM	FINCN	FINS	INZFIN	MISDAT	SAVEF
	SUBEXP	SYNTHS				
F2WORK	AERO	ASECT	DAMP	DUMPRT	FGEOM	FINCA
	FINCM	FINCN	FINS	INZFIN	MISDAT	SAVEF
	SUBEXP	SYNTHS				
F3WORK	AERO	ASECT	DAMP	DUMPRT	FGEOM	FINCA
	FINCM	FINCN	FINS	INZFIN	MISDAT	SAVEF
	SUBEXP	SYNTHS				
F4WORK	AERO	ASECT	DAMP	DUMPRT	FGEOM	FINCA
	FINCM	FINCN	FINS	INZFIN	MISDAT	SAVEF
	SUBEXP	SYNTHS				
FFINDL	AERO	MISDAT	PRINTS	SYNTHS	TRIMIT	
FLC	AERO	ASECT	AXINWT	BDPART	BETADR	BODCFD
	BODNWT	BODYA	BODYCA	BODYCM	BODYCN	BODYE
	CAINC	CMINC	CNINC	CNPAXI	CNPTWO	CSLINC
	CSNINC	CVRFLT	CYINC	CYPAXI	CYPDIV	CYPTWO
	DAMP	DDSYN	DIVCFD	DIVNWT	DUMPRT	DWRITE
	FAPART	FINCM	FINCN	FINS	FINXCA	FLTCDS
	GEOINL	HINGEM	ILTANG	ILTARO	ILTCDC	ILTCFD
	ILTFR	ILTNWT	ILTRVX	ILTSWT	ILTVIN	ILTVIS
	INLETA	INZFLC	LINFOR	LINXCP	MAJERR	MISDAT
	MOMFOR	PLOT3	PLTTRM	POTAR1	POTAR2	POTAR3
	PRIFLC	PRIIOM	PRINTS	PRITRM	PRIUNT	READNL
	SAVEF	SUBEXP	SUPBOD	SUPPOT	SYNTHS	TRIMIT
	WRFLT					
FSET1	AERO	ASECT	CVRFIN	DAMP	DUMPRT	F1GEOM
	FGEOM	FINCA	FINCN	FINS	GEOFIN	GEOM
	INZFIN	MAJERR	MISDAT	PRIF1	PRIIOM	PRINTS
	PRITRM	PRIUNT	READNL	SAVEF	SUPBOD	SYNTHS
	TRIMIT	WRFIN1				
FSET2	AERO	ASECT	CVRFIN	DAMP	DUMPRT	F2GEOM
	FGEOM	FINCA	FINCN	FINS	GEOFIN	GEOM
	INZFIN	MAJERR	MISDAT	PRIF2	PRIIOM	PRINTS
	PRITRM	PRIUNT	READNL	SAVEF	SUPBOD	SYNTHS
	TRIMIT	WRFIN2				
FSET3	AERO	ASECT	CVRFIN	DAMP	DUMPRT	F3GEOM
	FGEOM	FINCA	FINCN	FINS	GEOFIN	GEOM
	INZFIN	MAJERR	MISDAT	PRIF3	PRIIOM	PRINTS
	PRITRM	PRIUNT	READNL	SAVEF	SUPBOD	SYNTHS
	TRIMIT	WRFIN3				
FSET4	AERO	ASECT	CVRFIN	DAMP	DUMPRT	F4GEOM
	FGEOM	FINCA	FINCN	FINS	GEOFIN	GEOM
	INZFIN	MAJERR	MISDAT	PRIF4	PRIIOM	PRINTS
	PRITRM	PRIUNT	READNL	SAVEF	SUPBOD	SYNTHS
	TRIMIT	WRFIN4				
GEOBOD	AERO	BODCFD	BODYCA	BODYCM	BODYCN	BODYE
	CVRBOD	DAMP	DUMPRT	GEOAXI	GEOELL	GEOINL
	ILTFR	ILTSWT	INZBOD	LINFOR	MISDAT	PRIAXI
	PRIELL	SAVEF	SUPBOD	SUPPOT	SYNTHS	USEREL
	USERS					
GEOFC	FINCM	FINCN	FINS	MISDAT		
GEOFS1	AERO	ASECT	CVRFIN	DAMP	DUMPRT	F1GEOM
	FGEOM	FINCA	FINCM	FINS	GEOFIN	INZFIN
	MISDAT	PRIF1	SAVEF	SYNTHS		
GEOFS2	AERO	ASECT	CVRFIN	DAMP	DUMPRT	F2GEOM
	FGEOM	FINCA	FINCM	FINS	GEOFIN	INZFIN
	MISDAT	PRIF2	SAVEF	SYNTHS		
GEOFS3	AERO	ASECT	CVRFIN	DAMP	DUMPRT	F3GEOM
	FGEOM	FINCA	FINCM	FINS	GEOFIN	INZFIN
	MISDAT	PRIF3	SAVEF	SYNTHS		
GEOFS4	AERO	ASECT	CVRFIN	DAMP	DUMPRT	F4GEOM
	FGEOM	FINCA	FINCM	FINS	GEOFIN	INZFIN
	MISDAT	PRIF4	SAVEF	SYNTHS		
ILTGEO	AXINWT	BODCFD	BODNWT	CNPAXI	CNPTWO	CYPAXI
	CYPDIV	CYPTWO	DIVCFD	DIVNWT	GEOINL	ILTANG
	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT	ILTRVX
	ILTSWT	ILTVIN	ILTVIS	LINFOR	LINXCP	MOMFOR
	POTAR1	POTAR2	POTAR3			
ILTVSC	AXINWT	BODCFD	BODNWT	CNPAXI	CNPTWO	CYPAXI
	CYPDIV	CYPTWO	DIVCFD	DIVNWT	GEOINL	ILTANG
	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT	ILTRVX
	ILTSWT	ILTVIN	ILTVIS	LINFOR	LINXCP	MOMFOR
	POTAR1	POTAR2	POTAR3			

Figure 57 Common Block/Subroutine Cross Reference (Listed by Common Block) - Continued

Common Block	Used by Module(s):					
INC	AERO	CAINC	CMINC	CNINC	CSLINC	CSNINC
	CYINC	IN2FLC	IN2FLG	MISDAT	SYNTHS	
INCID	AERO	CVRFIN	GEOFIN	IN2TRM	MISDAT	PRIIOM
	PRINTS	READNL	SAVEF	SYNTHS	TRIMIT	WRDEFL
INLETN	AXINWT	BODCFD	BODNWT	CNPAXI	CNPTWO	CVRBOD
	CYPAXI	CYPDIV	CYPTWO	DIVCFD	DIVNWT	DUMPRT
	GEOINL	ILTANG	ILTARO	ILTCDC	ILTCFD	ILTFR
	ILTNWT	ILTRVX	ILTSWT	ILTVIN	ILTVIS	INLETA
	INLETG	IN2BOD	LINFOR	LINXCP	MAJERR	MISDAT
	MOMFOR	POTAR1	POTAR2	POTAR3	READNL	SAVEF
	WINLET					
INLTD	DUMPRT	ILTARO	INLETA	IN2BOD	MISDAT	SAVEF
INPCON	BLOCKD	CONERR	NMLIST	READIN	SAVEF	
INTERPP	CKDAT					
LINEAR	AXINWT	BODCFD	BODNWT	CNPAXI	CNPTWO	CYPAXI
	CYPDIV	CYPTWO	DIVCFD	DIVNWT	GEOINL	ILTANG
	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT	ILTRVX
	ILTSWT	ILTVIN	ILTVIS	LINFOR	LINXCP	MOMFOR
	POTAR1	POTAR2	POTAR3			
LOGIC	AERO	ASECT	BETADR	BODY	BODYA	BODYE
	CDPROT	CONTRL	CONVRT	CVRFLT	DAMP	DDSYN
	DUMPRT	DWRITE	FGEOM	FINCM	FINCN	FINS
	FINXCA	GEOAXI	GEOELL	GEOFIN	GEOM	GETNLN
	IN2FLG	MAJERR	MISDAT	PLOT3	PLTTRM	PRIAXI
	PRIELL	PRIF1	PRIF2	PRIF3	PRIF4	PRIFIN
	PRIFLC	PRIIOM	PRINT	PRINTS	PRIUNT	READIN
	READNL	SAVEF	SUBEXP	SUPPOT	SYNTHS	TRIMIT
	WRITNL					
MOMEN	AXINWT	BODCFD	BODNWT	CNPAXI	CNPTWO	CYPAXI
	CYPDIV	CYPTWO	DIVCFD	DIVNWT	GEOINL	ILTANG
	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT	ILTRVX
	ILTSWT	ILTVIN	ILTVIS	LINFOR	LINXCP	MOMFOR
	POTAR1	POTAR2	POTAR3			
PAERO	DAMP	HINGEM	IN2BOD	MISDAT	SAVEF	SYNPAR
	SYNTHS					
PARTF	AIRFOL	ASOSL	BETADR	BLUNT	BODYA	BODYCA
	BODYE	CCARD	CDPROT	CHKEND	CONERR	CONTRL
	FCAWPF	FINCM	FINCN	FINS	FINXCA	GEOAXI
	GEOELL	GEOINL	HINGEM	HSOSL	HYBG1	ILTARO
	MAJERR	MISDAT	PRIFIN	PRINT	READIN	SLOPE
	SUBNAM	SUBNM2	SUPBOD	SYNTHS	TESTOR	THEORY
	TRIMIT	VANDYK				

Common Block	Used by Module(s):					
POTENT	AXINWT	BODCFD	BODNWT	CNPAXI	CNPTWO	CYPAXI
	CYPDIV	CYPTWO	DIVCFD	DIVNWT	GEOINL	ILTANG
	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT	ILTRVX
	ILTSWT	ILTVIN	ILTVIS	LINFOR	LINXCP	MOMFOR
	POTAR1	POTAR2	POTAR3			
REFQN	AERO	AXINWT	BASPRS	BODCFD	BODNWT	BODYA
	BODYCA	BODYCM	BODYCN	BODYE	CNPAXI	CNPTWO
	CVRREF	CYPAXI	CYPDIV	CYPTWO	DAMP	DIVCFD
	DIVNWT	DUMPRT	FINCM	FINCN	FINS	FINXCA
	GEOAXI	GEOELL	GEOFIN	GEOINL	GEOM	GETCNO
	ILTANG	ILTARO	ILTCDC	ILTCFD	ILTFR	ILTNWT
	ILTRVX	ILTSWT	ILTVIN	ILTVIS	IN2REF	LINFOR
	LINXCP	MAJERR	MISDAT	MOMFOR	PLOT3	PLTTRM
	POTAR1	POTAR2	POTAR3	PRIFLC	PRIIOM	READNL
	SAVEF	SUBEXP	SUPBOD	SUPPOT	SYNTHS	WRREFQ
SB1	BETADR	BLKLDD	DAMP	DDSYN	DUMPRT	IN2IOM
	MISDAT	PRINTS	SAVEF	SYNTHS	TRIMIT	
SB12	BETADR	BLKLDD	DAMP	DDSYN	DUMPRT	IN2IOM
	MISDAT	PRINTS	SAVEF	SYNTHS	TRIMIT	
SB123	BETADR	BLKLDD	DAMP	DDSYN	DUMPRT	IN2IOM
	MISDAT	PRINTS	SAVEF	SYNTHS	TRIMIT	
SB1234	BETADR	BLKLDD	DAMP	DDSYN	DUMPRT	IN2IOM
	MISDAT	PRINTS	SAVEF	SYNTHS	TRIMIT	
SBODY	AERO	BDPART	BETADR	BLKLDD	BODYA	BODYCA
	BODYCM	BODYCN	BODYE	DAMP	DDSYN	DUMPRT
	IN2IOM	MISDAT	PRINTS	SAVEF	SUBEXP	SUPBOD
	SYNTHS					
SECVAR	AERO	AIRFOL	MISDAT			
SFIN1	AERO	BETADR	DAMP	DDSYN	DUMPRT	FINCA
	FINCM	FINCN	FINS	IN2IOM	MISDAT	PRINTS
	SAVEF	SUBEXP				
SFIN2	AERO	BETADR	DAMP	DDSYN	DUMPRT	FINCA
	FINCM	FINCN	FINS	IN2IOM	MISDAT	PRINTS
	SAVEF	SUBEXP				
SFIN3	AERO	BETADR	DAMP	DDSYN	DUMPRT	FINCA
	FINCM	FINCN	FINS	IN2IOM	MISDAT	PRINTS
	SAVEF	SUBEXP				
SFIN4	AERO	BETADR	DAMP	DDSYN	DUMPRT	FINCA
	FINCM	FINCN	FINS	IN2IOM	MISDAT	PRINTS
	SAVEF	SUBEXP				

Figure 57 Common Block/Subroutine Cross Reference (Listed by Common Block) - Continued

Common Block	Used by Module(s):					
THERY	CONTRL	FINXCA	INZFLG	LMSC	MISDAT	PRINTS
	SAVEF	SUPPOT	USEREL	USERS		
TOTALC		AERO	BODYA	BODYCA	BODYCM	BODYCN
	BODYE	DUMPRT	FINCM	FINCN	FINS	FLTCDS
	INZFLC	MISDAT	SAVEF	SUPBOD		
TRACE	BLOCKD	ETRACE	MESSG	SAVEF	STRACE	
TRIMD	INZTRM	MISDAT	PLTTRM	SAVEF	TRIMIT	
TRIMIN	INZTRM	MISDAT	READNL	SAVEF	TRIMIT	WRTRIM
UDATA	PRIIOM					
UTRIMD	INZTRM	MISDAT	PLTTRM	PRIUNT	SAVEF	TRIMIT
VANVAR	DISC2	HYBINZ	MISDAT	VANDYK		
VARNAM	BLOCKD	CONERR	NMLIST			
VDARY	AXBNDY	BLUNT	DELV	DISC2	HYBG1	HYBG2
	HYBINZ	MISDAT	NEWT	SIMP	SUMPOT	VANDYK
	WAVE					
XRBLNT	BODYCA	GEOAXI	GEOELL	USEREL	USERS	

Common Block | Used by Module(s):

Figure 57 Common Block/Subroutine Cross Reference (Listed by Common Block) - Continued

Module	Common Blocks Used:					
ADDECG	CONST					
AERO	ABODIN	BDWORK	CASEID	CONST	F1WORK	F2WORK
	F3WORK	F4WORK	FFINDL	FLC	FSET1	FSET2
	FSET3	FSET4	GEOBOD	GEOFS1	GEOFS2	GEOFS3
	GEOFS4	INC	INCID	LOGIC	REFQN	SBODY
	SECVAR	SFIN1	SFIN2	SFIN3	SFIN4	TOTALC
AFTCAP	CAFD					
AIRFOL	PARTF	SECVAR				
ALPBET	CONST					
ALPEQ	CONST					
ANGDET						
ARCCA	CAFD					
ARCOR						
ARSECH						
ASECT	ASMVAR	CONST	DESIG	F1WORK	F2WORK	F3WORK
	F4WORK	FLC	FSET1	FSET2	FSET3	FSET4
	GEOFS1	GEOFS2	GEOFS3	GEOFS4	LOGIC	
ASOSL	CAFD	CONST	PARTF			
ASPECT						
ATMOS						
AXBNDY	VDARY					
AXIMWT	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN
AXZU	CONST					
BASPRS	REFQN					
BCNAD						
BDAMP						
BDCAB	CONST					
BDCALP	CONST					
BDCAP1						

Module	Common Blocks Used:					
BDCAP2						
BDCAPR						
BDCAWC						
BDCAWF	CONST					
BDCAWN						
BDCDRV						
BDCMP	CONST					
BDCMV	CONST					
BDCNAB						
BDCNAF	CONST					
BDCNAN						
BDCNP	CONST					
BDCNV	CONST					
BDPART	ABODIN	BDWORK	CONST	FLC	SBODY	
BDXCPB	CONST					
BDXCPF						
BDXCPN						
BETADR	CASEID	CONST	FLC	LOGIC	PARTF	SB1
	SB12	SB123	SB1234	SBODY	SFIN1	SFIN2
	SFIN3	SFIN4				
BETAU	CONST					
BITSS	BITS					
BLKLDD	CONST	SB1	SB12	SB123	SB1234	SBODY
BLOCKD	CONST	INPCON	TRACE	VARNAM		
BLUNT	CONST	PARTF	VDARY			
BLUNTN						
BODCFD	BODVSC	CFFLOW	CONST	DIVVSC	FLC	GEOBOD

Figure 58 Common Block/Subroutine Cross Reference (Listed by Subroutine)

Module	Common Blocks Used:					
	ILTGEO REFQN	ILTVSC	INLETN	LINEAR	MOMEN	POTENT
BODNWT	BODVSC ILTVSC	CFFLOW INLETN	CONST LINEAR	DIVVSC MOMEN	FLC POTENT	ILTGEO REFQN
BODVAR						
BODY	LOGIC					
BODYA	ABODIN REFQN	BDWORK SBODY	CONST TOTALC	FLC	LOGIC	PARTF
BODYCA	ABODIN REFQN	BDWORK SBODY	CONST TOTALC	FLC XRBLNT	GEOBOD	PARTF
BODYCM	ABODIN SBODY	BDWORK TOTALC	CONST	FLC	GEOBOD	REFQN
BODYCN	ABODIN SBODY	BDWORK TOTALC	CONST	FLC	GEOBOD	REFQN
BODYE	ABODIN PARTF	BDWORK REFQN	CONST SBODY	FLC TOTALC	GEOBOD	LOGIC
BOTCA						
BOTCNM						
BQDER						
BSUB						
BUILD						
CAFRIC	CONST					
CAINC	CONST	FLC	INC			
CALIB						
CARRYO	CONST					
CARRYS	CONST					
CCARD	CONST	PARTF				
CDCS	CONST					
CDPRES	CONST					
CDPROT	ABODIN	LOGIC	PARTF			

Module	Common Blocks Used:					
CHKEND	PARTF					
CIRC						
CKDAT	CKDATA	INTERPP				
CLMAX	CONST					
CLOCD	CONST					
CLVR	CONST					
CMINC	CONST	FLC	INC			
CNEWT	DERIV					
CNINC	CONST	FLC	INC			
CNNEWT	CONST					
CNPAXI	BODVSC ILTVSC	CFFLOW INLETN	CONST LINEAR	DIVVSC MOMEN	FLC POTENT	ILTGEO REFQN
CNPTWO	BODVSC ILTVSC	CFFLOW INLETN	CONST LINEAR	DIVVSC MOMEN	FLC POTENT	ILTGEO REFQN
CNSBT	CONST					
CONEP						
CONERR	CONST	INPCON	PARTF	VARNAM		
CONIC	CONST					
CONTRL	CASEID THERY	DESIG	DFLAGS	DUMPF	LOGIC	PARTF
CONVRT	CONST	LOGIC				
COORD1	CONST					
COORD4						
COORD5						
COORD6	CONST					
CORD4M	CONST					
CORD5M						

Figure 58 Common Block/Subroutine Cross Reference (Listed by Subroutine) - Continued

Module	Common Blocks Used:					
CORDSP	CONST					
CP3DW	CAFD	CONST				
CPCAL						
CPDIST	CONST					
CROSS						
CSLINC	CONST	FLC	INC			
CSNINC	CONST	FLC	INC			
CUBIC						
CVRBOD	ABODIN	GEOBOD	INLETN			
CVRFIN	FSET1	FSET2	FSET3	FSET4	GEOFS1	GEOFS2
	GEOFS3	GEOFS4	INCID			
CVRFLT	CONST	FLC	LOGIC			
CVRREF	REFQN					
CVRTFT						
CVRTUS						
CYINC	CONST	FLC	INC			
CYL						
CYPAXI	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN
CYPDIV	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN
CYPTWO	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN
DAMP	ABODIN	CONST	F1WORK	F2WORK	F3WORK	F4WORK
	FLC	FSET1	FSET2	FSET3	FSET4	GEOBOD
	GEOFS1	GEOFS2	GEOFS3	GEOFS4	LOGIC	PAERO
	REFQN	SB1	SB12	SB123	SB1234	SBODY
	SFIN1	SFIN2	SFIN3	SFIN4		
DDECOD						
DDSYN	CONST	DB1	DB12	DB123	DB1234	DBODY
	DDFIN1	DDFIN2	DDFIN3	DDFIN4	FLC	LOGIC

Module	Common Blocks Used:					
	SB1	SB12	SB123	SB1234	SBODY	SFIN1
	SFIN2	SFIN3	SFIN4			
DECODE						
DELNMS	DFLAGS					
DELV	VDARY					
DIHED						
DISC2	CONST	VANVAR	VDARY			
DIVCFD	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN
DIVNWT	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN
DMPARY						
DREAD						
DSPLAN	CONST					
DSWET	CONST					
DSWETE	CONST					
DUMPRT	ABODIN	BDWORK	CONST	DB1	DB12	DB123
	DB1234	DBODY	DDFIN1	DDFIN2	DDFIN3	DDFIN4
	DUMPF	F1WORK	F2WORK	F3WORK	F4WORK	FLC
	FSET1	FSET2	FSET3	FSET4	GEOBOD	GEOFS1
	GEOFS2	GEOFS3	GEOFS4	INLETN	INLTD	LOGIC
	REFQN	SB1	SB12	SB123	SB1234	SBODY
	SFIN1	SFIN2	SFIN3	SFIN4	TOTALC	
DVOL	CONST					
DVOLE	CONST					
DWRITE	DB1	DB12	DB123	DB1234	DBODY	DDFIN1
	DDFIN2	DDFIN3	DDFIN4	FLC	LOGIC	
DXCENP	CONST					
DXCENV	CONST					
DXCNVE	CONST					
ELLIP1						

Figure 58 Common Block/Subroutine Cross Reference (Listed by Subroutine) - Continued

Module	Common Blocks Used:		
ELLIP2			
ELLKWB			
EQN44			
ETRACE	TRACE		
EVAL			
EXPAND			
EXTRAP			
EXTRST			
F1GEOM	CONST	FSET1	GEOFS1
F2GEOM	CONST	FSET2	GEOFS2
F3GEOM	CONST	FSET3	GEOFS3
F4GEOM	CONST	FSET4	GEOFS4
FALCP	CONST		
FAPART	FLC		
FCALE	CONST		
FCALP	CONST		
FCAWPF	CAFD	CONST	PARTF
FCAWS	CONST		
FCAWT	CONST		
FCLMSB	CONST		
FCLMSH	CONST		
FCNA	CONST		
FCNAA			
FCNAAH	CONST		
FCNAAS	CONST		
FCNAAT	CONST		

Module	Common Blocks Used:					
FCNASB	CONST					
FCNASP	CONST					
FCNATR	CONST					
FD5						
FDAMP						
FDP5						
FGEOM	CONST	DESIG	F1WORK	F2WORK	F3WORK	F4WORK
	FSET1	FSET2	FSET3	FSET4	GEOFS1	GEOFS2
	GEOFS3	GEOFS4	LOGIC			
FIG60B	CONST					
FINCA	F1WORK	F2WORK	F3WORK	F4WORK	FSET1	FSET2
	FSET3	FSET4	GEOFS1	GEOFS2	GEOFS3	GEOFS4
	SFIN1	SFIN2	SFIN3	SFIN4		
FINCAB						
FINCAP						
FINCEN	CONST					
FINCM	ABODIN	CONST	F1WORK	F2WORK	F3WORK	F4WORK
	FLC	GEOFC	GEOFS1	GEOFS2	GEOFS3	GEOFS4
	LOGIC	PARTF	REFQN	SFIN1	SFIN2	SFIN3
	SFIN4	TOTALC				
FINCN	CONST	F1WORK	F2WORK	F3WORK	F4WORK	FLC
	FSET1	FSET2	FSET3	FSET4	GEOFC	LOGIC
	PARTF	REFQN	SFIN1	SFIN2	SFIN3	SFIN4
	TOTALC					
FINDCH						
FINDVN						
FINFIN	CONST					
FINMGC						
FINPLN						
FINS	CONST	F1WORK	F2WORK	F3WORK	F4WORK	FLC
	FSET1	FSET2	FSET3	FSET4	GEOFC	GEOFS1
	GEOFS2	GEOFS3	GEOFS4	LOGIC	PARTF	REFQN
	SFIN1	SFIN2	SFIN3	SFIN4	TOTALC	

Figure 58 Common Block/Subroutine Cross Reference (Listed by Subroutine) - Continued

Module	Common Blocks Used:					
FINVAR						
FINXCA	CONST	FLC	LOGIC	PARTF	REFQN	THERY
FIT						
FLAPS	CONST					
FLAT						
FLTCDS	CONST	FLC	TOTALC			
FMPART						
FNPART	CONST					
FOIL	CONST					
FORINT						
FORLOG						
FORREA						
FRCOR						
FSDETA	CONST					
FWDXAC	CONST					
GEO						
GEOAXI	ABODIN XRBLNT	CONST	GEOBOD	LOGIC	PARTF	REFQN
GEOELL	ABODIN XRBLNT	CONST	GEOBOD	LOGIC	PARTF	REFQN
GEOFIN	CONST GEOFS2	FSET1 GEOFS3	FSET2 GEOFS4	FSET3 INCID	FSET4 LOGIC	GEOFS1 REFQN
GEOINL	BODVSC ILTGEO POTENT	CFFLOW ILTVSC REFQN	CONST INLETN	DIVVSC LINEAR	FLC MOMEN	GEOBOD PARTF
GEOM	ABODIN LOGIC	CONST REFQN	FSET1	FSET2	FSET3	FSET4
GETCNO	CONST	REFQN				
GETETA						

Module	Common Blocks Used:					
GETNLN	CONST	LOGIC				
HAACK	CONST					
HEADER	CASEID					
HEXCA	CAFD					
HINGEM	CONST	FLC	PAERO	PARTF		
HSOSL	CAFD	CONST	PARTF			
HXZU	CONST					
HYBG1	PARTF	VDARY				
HYBG2	VDARY					
HYBINZ	CONST	VANVAR	VDARY			
HYBRID						
HYBSET	ABODIN	CONST				
HYPER						
HYPERS	CONST					
IAD2D	CONST					
IADAXI	CONST					
IDEAL	ASMVAR	CONST				
ILTANG	BODVSC ILTVSC	CFFLOW INLETN	CONST LINEAR	DIVVSC MOMEN	FLC POTENT	ILTGEO REFQN
ILTARO	ABODIN ILTGEO PARTF	BODVSC ILTVSC POTENT	CFFLOW INLETN REFQN	CONST INLTD	DIVVSC LINEAR	FLC MOMEN
ILTCDC	BODVSC ILTVSC	CFFLOW INLETN	CONST LINEAR	DIVVSC MOMEN	FLC POTENT	ILTGEO REFQN
ILTCFD	BODVSC ILTVSC	CFFLOW INLETN	CONST LINEAR	DIVVSC MOMEN	FLC POTENT	ILTGEO REFQN
ILTFR	BODVSC ILTGEO REFQN	CFFLOW ILTVSC	CONST INLETN	DIVVSC LINEAR	FLC MOMEN	GEOBOD POTENT

Figure 58 Common Block/Subroutine Cross Reference (Listed by Subroutine) - Continued

Module	Common Blocks Used:
ILTNWT	BODVSC CFFLOW CONST DIVVSC FLC ILTGEO ILTVSC INLETN LINEAR MOMEN POTENT REFQN
ILTRVX	BODVSC CFFLOW CONST DIVVSC FLC ILTGEO ILTVSC INLETN LINEAR MOMEN POTENT REFQN
ILTSWT	BODVSC CFFLOW CONST DIVVSC FLC GEOBOD ILTGEO ILTVSC INLETN LINEAR MOMEN POTENT REFQN
ILTVIN	BODVSC CFFLOW CONST DIVVSC FLC ILTGEO ILTVSC INLETN LINEAR MOMEN POTENT REFQN
ILTVIS	BODVSC CFFLOW CONST DIVVSC FLC ILTGEO ILTVSC INLETN LINEAR MOMEN POTENT REFQN
INDEXS	
INITZ	
INLETA	FLC INLETN INLTD
INLETG	INLETN
INSBLK	
INTER4	
INTER5	
INTERP	
INZBOD	ABODIN CONST GEOBOD INLETN INLTD PAERO
INZDYN	BITS CONST DERIV
INZFIN	CONST DESIG F1WORK F2WORK F3WORK F4WORK FSET1 FSET2 FSET3 FSET4 GEOFS1 GEOFS2 GEOFS3 GEOFS4
INZFLC	CONST FLC INC TOTALC
INZFLG	CASEID CONST DESIG DFLAGS DUMPF INC LOGIC THERY
INZIOM	BDWORK CONST DB1 DB12 DB123 DB1234 DBODY DDFIN1 DDFIN2 DDFIN3 DDFIN4 SB1 SB12 SB123 SB1234 SBODY SFIN1 SFIN2 SFIN3 SFIN4
INZREF	CONST REFQN
INZTRM	CONST INCID TRIMD TRIMIN UTRIMD
JAS26	
KWBALP	
LAM025	
LINFOR	BODVSC CFFLOW CONST DIVVSC FLC GEOBOD ILTGEO ILTVSC INLETN LINEAR MOMEN POTENT REFQN
LINXCP	BODVSC CFFLOW CONST DIVVSC FLC ILTGEO ILTVSC INLETN LINEAR MOMEN POTENT REFQN
LIPCOR	
LMSC	CONST DERIV THERY
LNSTAR	DERIV
LNTRP	
LOADF	
LOOK	
LOOK1	
LOOK2	
LOOK3	
LOOP	
LUCERO	
LUGSHO	
LVALUE	CONST
MAJERR	ABODIN CONST FLC FSET1 FSET2 FSET3 FSET4 INLETN LOGIC PARTF REFQN
MATCHX	
MDIV	
MESSG	CASEID TRACE
MISDAT	ABODIN ASMVAR BDWORK CASEID DB1 DB12 DB123 DB1234 DBODY DDFIN1 DDFIN2 DDFIN3

Figure 58 Common Block/Subroutine Cross Reference (Listed by Subroutine) - Continued

Module	Common Blocks Used:					
	DDFIN4	DESIG	DFLAGS	DUMPF	F1WORK	F2WORK
	F3WORK	F4WORK	FFINDL	FLC	FSET1	FSET2
	FSET3	FSET4	GEOBOD	GEOFC	GEOFS1	GEOFS2
	GEOFS3	GEOFS4	INC	INCID	INLETN	INLTD
	LOGIC	PAERO	PARTF	REFQN	SB1	SB12
	SB123	SB1234	SBODY	SECVAR	SFIN1	SFIN2
	SFIN3	SFIN4	THERY	TOTALC	TRIMD	TRIMIN
	UTRIMD	VANVAR	VDARY			
MOMFOR	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN
MVLOOK						
NAMER						
NAMEW						
NDIV						
NEWT	CONST	VDARY				
NEWTON	CONST					
NMLIST	CONST	INPCON	VARNAM			
NMTEST						
OGIVE	CONST					
PACK	CONST					
PANLCH	CONST					
PARAB						
PLATE						
PLOT3	CASEID	CONST	FLC	LOGIC	REFQN	
PLTTRM	CASEID	CONST	FLC	LOGIC	REFQN	TRIMD
	UTRIMD					
POLINT						
POTAR1	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN
POTAR2	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN
POTAR3	BODVSC	CFFLOW	CONST	DIVVSC	FLC	ILTGEO
	ILTVSC	INLETN	LINEAR	MOMEN	POTENT	REFQN

Module	Common Blocks Used:					
POWR	CONST					
PRIAXI	ABODIN	CONST	GEOBOD	LOGIC		
PRIELL	ABODIN	CONST	GEOBOD	LOGIC		
PRIF1	CONST	FSET1	GEOFS1	LOGIC		
PRIF2	CONST	FSET2	GEOFS2	LOGIC		
PRIF3	CONST	FSET3	GEOFS3	LOGIC		
PRIF4	CONST	FSET4	GEOFS4	LOGIC		
PRIFIN	LOGIC	PARTF				
PRIFLC	CONST	FLC	LOGIC	REFQN		
PRIIOM	CASEID	CONST	FLC	FSET1	FSET2	FSET3
	FSET4	INCID	LOGIC	REFQN	UDATA	
PRINT	LOGIC	PARTF				
PRINTS	CONST	FFINDL	FLC	FSET1	FSET2	FSET3
	FSET4	INCID	LOGIC	SB1	SB12	SB123
	SB1234	SBODY	SFIN1	SFIN2	SFIN3	SFIN4
	THERY					
PRITRM	CONST	FLC	FSET1	FSET2	FSET3	FSET4
PRIUNT	FLC	FSET1	FSET2	FSET3	FSET4	LOGIC
	UTRIMD					
QUAD1						
RARBOD	CONST					
RAXIS	CONST					
RDEFL	CONST					
READCD						
READIN	CASEID	DFLAGS	INPCON	LOGIC	PARTF	
READNL	ABODIN	FLC	FSET1	FSET2	FSET3	FSET4
	INCID	INLETN	LOGIC	REFQN	TRIMIN	
RELLB	CONST					

Figure 58 Common Block/Subroutine Cross Reference (Listed by Subroutine) - Continued

Module	Common Blocks Used:					
REPTCT						
REXPR	CONST					
RFIN1	CONST					
RFIN2	CONST					
RFIN3	CONST					
RFIN4	CONST					
RFINS						
RFLT	CONST					
RINLET	CONST					
RREFQ	CONST					
RTRIM	CONST					
RVALUE	CONST					
SAVEF	ABODIN	BDWORK	CASEID	CONST	DB1	DB12
	DB123	DB1234	DBODY	DESIG	DFIN1	DFIN2
	DFIN3	DFIN4	DFLAGS	DUMPF	F1WORK	F2WORK
	F3WORK	F4WORK	FLC	FSET1	FSET2	FSET3
	FSET4	GEOBOD	GEOFS1	GEOFS2	GEOFS3	GEOFS4
	INCID	INLETN	INLTD	INPCON	LOGIC	PAERO
	REFQN	SB1	SB12	SB123	SB1234	SBODY
	SFIN1	SFIN2	SFIN3	SFIN4	THERY	TOTALC
	TRACE	TRIMD	TRIMIN	UTRIMD		
SBLAMO						
SETGEO						
SFCHAD	BITS					
SFCHQ	BITS					
SFCNAD	BITS					
SFCNQ	BITS					
SFWRN	CONST					
SHOCK						
SIMP	VDARY					

Module	Common Blocks Used:				
SIMPW					
SKINF					
SKIPBL					
SLEQ					
SLOPE	ASMVAR	CONST	PARTF		
SORT					
SOSE	CONST				
SPHERE	CONST				
SPIN#3	DBODY				
SPLIN2					
SPLINE					
SPLN2					
SRATIO					
SSADER					
SSCHQ					
SSQDER					
STANR	DERIV				
STBODY					
STRACE	TRACE				
STREAM					
SUBDER					
SUBEXP	CONST	F1WORK	F2WORK	F3WORK	F4WORK
FLC	LOGIC	REFQN	SBODY	SFIN1	SFIN2
SFIN3	SFIN4				
SUBINT					
SUBLOG					
SUBNAM	PARTF				

Figure 58 Common Block/Subroutine Cross Reference (Listed by Subroutine) - Continued

Module	Common Blocks Used:					
SUBNM2	PARTF					
SUBREA						
SUMPOT	VDARY					
SUPBOD	ABODIN	BDWORK	CONST	FLC	FSET1	FSET2
	FSET3	FSET4	GEOBOD	PARTF	REFQN	SBODY
	TOTALC					
SUPPOT	ABODIN	CONST	FLC	GEOBOD	LOGIC	REFQN
	THERY					
SUPXY						
SVRINT						
SVTRAK	CONST					
SWEEPN	CONST					
SWRITE	CONST					
SYNPAR	PAERO					
SYNTHS	ABODIN	BDWORK	CASEID	CONST	F1WORK	F2WORK
	F3WORK	F4WORK	FFINDL	FLC	FSET1	FSET2
	FSET3	FSET4	GEOBOD	GEOFS1	GEOFS2	GEOFS3
	GEOFS4	INC	INCID	LOGIC	PAERO	PARTF
	REFQN	SB1	SB12	SB123	SB1234	SBODY
TABLOK						
TCEFFT						
TESTOR	CONST	PARTF				
THEORY	ASMVAR	CONST	PARTF			
TODEC						
TOHOLL						
TOINT						
TOLOG						
TRANS						
TRIMIT	CASEID	CONST	FFINDL	FLC	FSET1	FSET2
	FSET3	FSET4	INCID	LOGIC	PARTF	SB1
	SB12	SB123	SB1234	TRIMD	TRIMIN	UTRIMD

Module	Common Blocks Used:				
USEFOL	CONST				
USEREL	ABODIN	CONST	GEOBOD	THERY	XRBLNT
USERS	ABODIN	CONST	GEOBOD	THERY	XRBLNT
VANDYK	CONST	PARTF	VANVAR	VDARY	
VNAME					
VRINTS	CONST				
WARBOD	ABODIN	CONST			
WAVE	CONST	VDARY			
WEDGE	CONST				
WELLB	ABODIN	CONST			
WINLET	CONST	INLETN			
WRAXIS	ABODIN	CONST			
WRDEFL	CONST	INCID			
WRFIN1	CONST	FSET1			
WRFIN2	CONST	FSET2			
WRFIN3	CONST	FSET3			
WRFIN4	CONST	FSET4			
WRFLT	CONST	FLC			
WRITNL	LOGIC				
WRREFQ	CONST	REFQN			
WRTRIM	CONST	TRIMIN			
YBAR					
YCP					
YMGC					

Figure 58 Common Block/Subroutine Cross Reference (Listed by Subroutine) - Continued

Internal Common Management Blocks
- CASEID
- CONST
- DUMPF
- DFLAGS
- LOGIC
- PARTF
- INPCON
- TRACE
- THERY

Input Common Blocks
- ABODIN
- DESIG
- DIVERN
- FLC
- FSET1
- FSET2
- FSET3
- FSET4
- INCID
- INLETN
- REFQN
- TOTALC
- TRIMIN

Internal Aerodynamic Work Arrays
- BDWORK
- F1WORK
- F2WORK
- F3WORK
- F4WORK
- INC
- PAERO

Geometry Arrays
- GEOBOD
- GEOFS1
- GEOFS2
- GEOFS3
- GEOFS4

Static Aerodynamic Results (I.O.M)
- INLTD
- SBODY
- SB1
- SB12
- SB123
- SB1234
- SFIN1
- SFIN2
- SFIN3
- SFIN4

Dynamic Aerodynamic Results (I.O.M.)
- DBODY
- DB1
- DB12
- DB123
- DB1234
- DDFIN1
- DDFIN2
- DDFIN3
- DDFIN4

Aerodynamic Trim Results
- UTRIMD
- TRIMD

Figure 59 Program Common Blocks By Data Type

5.3 AERODYNAMIC METHODOLOGY

This section briefly summarizes the method routines incorporated in the Missile Datcom code. Also covered in this section is the means to update or replace a method.

5.3.1 Methods Incorporated

The methods incorporated are summarized in Table 7. Each method is coded into its own subroutine so that revision or replacement is easily accomplished. Detailed documentation within the code using "comment cards" further describes the methods as well as their limitations.

5.3.2 *Changing a Method*

Replacing a component buildup method is easily done. Since each method is coded in an individual subroutine, simply replacing the method subroutine will implement the new technique. A few of the methods are complex an require several subroutines; these are called method modules. Method modules substitution is more complex but can still be easily accomplished. The program development philosophy, described below, will aid in method revision.

Code Structure: The code was developed using top-down design. This development scheme was implemented by coding at the top-most control logic downward to integration of the individual method subroutines. Hence, the upper levels of the code structure contain the basic logic to implement the component buildup methods. The lower levels are the implemented methods. In most cases the control logic requires no changes.

Method Coding Style: Most Methods are implemented in a single subroutine. Their inputs and outputs are passed through the subroutine calling sequence. Any method routine can be extracted and used in another code without modification. In some cases utility routines, such as table look-ups, are used; they must also be extracted if the method is to be used in another code.

Each subroutine includes a brief description of the inputs and outputs, the reference documentation, and any limitations or assumptions.

When any routine contains data tables, two subroutines calls are inserted so that the program execution sequence can be "tracked". The call to STRACE at the start of the subroutine places the name of the routine being executed (parameter IROUT) into the common block TRACE. The subroutine name is removed from the TRACE common block using the call to ETRACE at the end of the subroutine. These routines do not have any impact on other calculations of the program and the subroutine calls may be removed if the code is used in another program.

Execution Sequence: Subroutines BODY and FINS control the calculation sequence for body alone and fin alone, respectively. These two routines are called by the master aerodynamic calculation subroutine AERO; this is where the Mach number and the flight conditions are defined for the user input case. the full configuration component build-up is done in subroutine SYNTHS.

The aerodynamics are calculated in the following sequence: 1) Normal force, 2) Axial force, 3) Pitching Moment, 4) Side Force, 5) Yawing Moment, 6) Rolling Moment, and 7) the derivatives of the above with respect to angle of attack and sideslip angle. In some cases, the calling sequence must not be changed since subsequent results are dependant upon other coefficients. For example, drag-to-lift is dependant upon normal force. Extreme caution must be exercised when revising the method execution sequence. It is recommended that the same example case be run with both the "old" and "new" versions of the code and any differences be reconciled.

Special options of the code such as experimental data substitution and configuration incrementing depend on the methods by which the aerodynamic coefficients are calculated. Both of these Options are executed in the subroutine SYNTHS. An example of these options dependence on the computation methods is the separation of C_N into C_{N0}, C_{Np} and C_{Nv}. Incrementing factors are applied to each of these components separately. Therefore, a change in the decomposition of C_N would effect the configuration incrementing option. Therefore any change in the method of computing an aerodynamic coefficient should be checked for synthesis ramifications.

Changing a Method Subroutine: Revising a method which is coded into a single subroutine is as simple as writing a routine with the same name and substituting it into the program. Any changes to the variables passed through the routine calling sequence must also be changed in those routines that call it. Data required which are not available in the calling sequence may be optionally added by inserting the appropriate common block (see Section 5.4). Care must be taken when using data from a common block to make sure that it has been computed prior to its attempted use.

Changing a Method Module: Four methods are too complex to be included as a single subroutine. They are the Airfoil Section Module, the Hybrid Theory Module, the Second Order Shock Expansion Module and the Supersonic Wing Potential Flow Module. These techniques are neither short nor easily changed. To replace each module with another technique, the following is recommended.

- Airfoil Section Module - this module starts with subroutine THEORY. To use another set of airfoil section calculations requires the revision of this subroutine.

- Hybrid Theory Module - The second-order potential flow solution of Van Dyke (Hybrid Theory) begins with subroutine HYBRID. Replacement of this method requires changes to subroutine SUPPOT.

- Second-Order Shock Expansion Theory Module - The Second-Order Shock Expansion method is implemented beginning with SOSE. Replacement of this method requires changes to subroutine SUPPOT.

- Supersonic Wing Potential Flow Module - The potential flow method for supersonic wave drag is implemented in subroutine FCAWPF. Replacement of this method is done in FINXCA.

Format of PLOT File: When the PLOT control card is used, a formatted data file is written to unit 3 which can be used in a separate plotting program. The file format can be seen in Appendix B.

Table 7 Summary of Methods Implemented in Missile Datcom

Coeff	ROUTINE	DESCRIPTION	REFERENCES
α_{EQ}	ALPEQ	COMPUTES EQUIVALENT ANGLE OF ATTACK OF FIN PANEL	J OF SPACECRAFT & ROCKETS, JULY-AUGUST 1983
δ^{*}	ANGDET	WEDGE TURN ANGLE FOR WHICH SHOCK WILL BECOME DETACHED	NACA 1135 EQNS. 138 & 168
C_{A_b}	BDCAB	COMPUTES BASE DRAG FOR BODIES AT ALL SPEEDS	NASA TR R-100 NSWC TR-81-156 (NSWC AERO CODE)
$C_{A(\alpha)}$	BDCALP	COMPUTES DRAG DUE TO LIFT FOR AXISYMMETRIC BODIES	AMCP 706-280
C_{A_p}	BDCAPR	COMPUTES SUBSONIC PRESSURE DRAG FOR BODIES	ALLEN AND PERKINS (NACA 1048)
$(C_{Ap})_{BT}$	BDCAP1	SUBSONIC-TRANSONIC PRESSURE DRAG COEFFICIENT (NO FRICTION) OF AXISYMMETRIC CONICAL BODIES	DATCOM SECTION 4.2.3.1
$(C_{Ap})_{BT}$	BDCAP2	SUBSONIC-TRANSONIC PRESSURE DRAG COEFFICIENT (NO FRICTION) OF AXISYMMETRIC OGIVAL BODIES	PAYNE-DTNSRDC/ASED-80/10 MAY, 1980, PP. 33-38
$C_{A_{p,w}}$	BDCAWC	CALCULATES PRESSURE/WAVE DRAG INCREMENT OF CONICAL NOSE CYLINDER AT TRANSONIC SPEEDS	MOORE, NSWC-TR-80-346, P. 28
C_{A_w}	BDCAWF	SUBSONIC-TRANSONIC WAVE DRAG COEFFICIENT OF AXISYMMETRIC CONICAL BODIES WITH FLARE	AMCP 706-280, FIGURE 8-33A TO 8-33D,P.8-49
C_{A_w}	BDCAWN	COMPUTES NOSE WAVE DRAG AT TRANSONIC SPEEDS USING CHAUSSEE, UNSTEADY EULER SOLUTION	NSWC TR-80-346, P.28
C_{m_p}	BDCMP	COMPUTES POTENTIAL PITCHING MOMENT FOR BODIES	ALLEN AND PERKINS (NACA 1048)
C_{m_v}	BDCMV	COMPUTES VISCOUS PITCHING MOMENT FOR BODIES ABOUT USER SPECIFIED CENTER OF GRAVITY	ALLEN AND PERKINS (NACA 1048)
$(C_{N\alpha})_{BT}$	BDCNAB	COMPUTES INCREMENTAL NORMAL FORCE SLOPE DUE TO CONICAL BOATTAIL ON AXISYMMETRIC BODIES	NSWC-TR-81-156, P.110
$(C_{N\alpha})_{FL}$	BDCNAF	COMPUTE INCREMENTAL NORAML FORCE SLOPE DUE TO FLARE AT SUBSONIC/TRANSONIC SPEEDS	AMCP 706-280, JULY 1968
C_{N_α}	BDCNAN	INTERPOLATE NORMAL FORCE COEFFICIENT SLOPE FOR CONE-CYLINDER AND OGIVE-CYLINDER AT TRANSONIC SPEEDS	MBB TN, WE2-97/69 MBB TN, WE12-88/70
C_{N_p}	BDCNP	COMPUTES POTENTAIL NORMAL FORCE FOR BODIES	ALLEN AND PERKINS (NACA 1048)
C_{N_v}	BDCNV	COMPUTES VISCOUS NORMAL FORCE FOR BODIES	ALLEN AND PERKINS (NACA 1048)
$(x_{cp})_{BT}$	BDXCPB	LOCATE AFT BODY CENTER OF PRESSURE (SLENDER BODY THEORY)	NSWC-TR-80-346,P.41
$(x_{cp})_{FL}$	BDXCPF	COMPUTES SUBSONIC/TRANSONIC FLARE CENTER OF PRESSURE	AMCP 706-280, JULY 1968
X_{cp}	BDXCPN	INTERPOLATE LONGITUDINAL CENTER OF PRESSURE FOR CONE-CYLINDER AND OGIVE-CYLINDER AT TRANSONIC SPEEDS	MBB TN, WE2-97/69 MBB TN, WE12-88/70
β_u	BETAU	DETERMINES THE REGION OF INFLUENCE OF PANEL IN PROXIMITY TO ANOTHER	ONR-CR215-226-4F, APPENDIX D
C_A	BODYCA	LINEARLY REDUCE PRESSURE DRAG IN MACH RANGE 1.0 - 1.2	DATCOM SECTION 4.1.5.1

Table 7 Summary of Methods Implemented in Missile Datcom (Continued)

Coeff	ROUTINE	DESCRIPTION	REFERENCES
C_{A_F}	CAFRIC	COMPUTE FRICTION COMPONENT OF AXIAL FORCE AT ANGLE OF ATTACK	MDAC-WEST AERODYNAMIC HANDBOOK (M 8.080-CD) DATCOM SECTION 4.1.5.1 FLUID DYNAMIC DRAG(HOERNER)
	CARRYO	COMPUTE FIN-BODY AND BODY-FIN CARRY-OVER FACTORS DUE TO ANGLE OF ATTACK AND INCIDENCE	NACA 1307 J. AIRCRAFT, OCTOBER 1975
	CARRYS	SUPERSONIC FIN-BODY CARRY OVER WITH FINITE AFTERBODIES	AIAA JOURNAL: VOL.19,NO.5,MAY 1981,P.661 VOL.20,NO.6,JUN 1982,P.855 VOL.20,NO.8,AUG 1982,P.1144
C_{d_c}	CDCS	COMPUTE CROSS FLOW DRAG COEFFICIENT (JORGENSEN) DATA FAIRING GUIDE (BAKER)	NASA TN D-6996, FIGS.1,2,3 AEDC-TR-75-124
$(\delta DEG)_v$	CLVR	COMPUTE PANEL LIFT INCREMENT DUE TO BODY VORTICES AS A FRACTION OF THE THEORETICAL PANEL LIFT	NWC TP-5761
Cp	CONEP	COMPUTE CONE PRESSURE AT ZERO ANGLE OF ATTACK (RASMUSSEN)	AIAA JOURNAL, AUG 1967, P.1495
$Cp(\alpha,\theta)$	CPDIST	COMPUTE PRESSURES AROUND BODY (DEJARNETTE EQNS.28)	AIAA JOURNAL OF SPACECRAFT, NOV-DEC 1980 P.529
M_2	EQN44	COMPUTE MACH NUMBER (FROM EQUATION 44)	NACA 1135
X_{Cp}	FALCP	CALCULATE FIN ALONE AERODYNAMIC CENTER FOR AFT SWEPT WINGS	DATCOM SECTION 4.1.4.2, FIGURES 26(A) - 26(F)
$C_{A_{LE}}$	FCALE	COMPUTE DRAG INCREMENT DUE TO LEADING LEADING EDGE BLUNTNESS	DATCOM SECTION 4.1.5.1
$C_{A(\alpha)}$	FCALP	COMPUTE DRAG DUE TO LIFT FOR FINS ALONE	DATCOM SECTION 4.1.5.2
C_{A_w}	FCAWPF	COMPUTE FIN ALONE WAVE DRAG AT SUPERSONIC SPEEDS	NSWC TR-80-346
C_{A_w}	FCAWS	SUPERSONIC FIN WAVE DRAG INCREMENT TO AXIAL FORCE	DATCOM SECTION 4.1.5.1
$C_{A_{p,w}}$	FCAWT	COMPUTE FIN ALONE TRANSONIC WAVE DRAG INCREMENT	DATCOM SECTION 4.1.5.1
$\alpha_{C_{L_{MAX}}}$ $C_{L_{MAX}}$	FCLMSB	COMPUTE SUBSONIC MAXIMUM LIFT AND ANGLE OF ATTACK FOR MAXIMUM LIFT FOR LOW ASPECT RATIO WINGS	DATCOM SECTION 4.1.3.4 METHOD 3
$\alpha_{C_{L_{MAX}}}$ $C_{L_{MAX}}$	FCLMSH	COMPUTE SUBSONIC MAXIMUM LIFT AND ANGLE OF ATTACK FOR MAXIMUM LIFT FOR HIGH ASPECT RATIO WINGS	DATCOM SECTION 4.1.3.4 METHOD 2
C_{N_α}	FCNA	COMPUTES FIN ALONE LINEAR NORMAL FORCE CURVE SLOPE, PER DEGREE	DATCOM SECTION 4.1.3.2 RAS DATA SHEETS
$C_{N_{\alpha\alpha}}$	FCNAAH	COMPUTES SUPERSONIC NON-LINEAR NORMAL FORCE PER $SIN^2\alpha$	DATCOM SECTION 4.1.3.3
$C_{N_{\alpha\alpha}}$	FCNAAS	COMPUTES SUBSONIC NON-LINEAR NORMAL FORCE PER $SIN^2\alpha$	DATCOM SECTION 4.1.3.3
$C_{N_{\alpha\alpha}}$	FCNAAT	COMPUTES TRANSONIC NON-LINEAR NORMAL FORCE PER $SIN^2\alpha$	DATCOM SECTION 4.1.3.3
C_{N_α}	FCNASB	COMPUTES FIN-ALONE LIFT CURVE SLOPE FOR TWO (2) PANELS CONNECTED AT THE ROOT CHORD (LOWRY-POLHAMUS)	DATCOM FIGURE 4.1.3.2
C_{N_α}	FCNASP	COMPUTES SUPERSONIC LIFTING SURFACE CN PER ALPHA	DATCOM FIGURE 4.1.3.2-56 DATCOM FIGURE 4.1.3.2-60 DAC SM 13110
C_{N_α}	FCNATR	COMPUTES FIN ALONE TRANSONIC LIFT CURVE SLOPE FOR TWO(2) PANELS (EXPOSED PLANFORM)	BRITISH DATA SHEETS: S.01.03.06, S.01.03.05 S.01.03.04, S.01.03.03 S.08.01.02

Table 7 Summary of Methods Implemented in Missile Datcom (Continued)

Coeff	ROUTINE	DESCRIPTION	REFERENCES
$C_{N_{\alpha\alpha}}^{*}$	FIG60B	INTERPOLATE FOR FIN CNAA (DATCOM FIGURE 4.1.3.3-60B)	DATCOM SECTION 4.1.3.3
C_{A_B}	FINCAB	COMPUTE BASE DRAG OF FIN TRAILING EDGE	NWC TR-2796 EMPIRICAL 0.0 < M < 3.1 3D 0.0 < M < 1.2 2D 1.2 < M < 3.1 $1/M^2$ M > 4.0
C_{A_p}	FINCAP	FIN ALONE SUBSONIC PRESSURE DRAG	FLUID DYNAMIC DRAG (HOERNER)
$(\Delta DEG)_\delta$	FINFIN	DETERMINE DELTA-ALPHA-EQUIVALENT OF DEFLECTED FIN IN PRESENCE OF ADJACENT CRUCIFORM FINS	NEAR TR 125
$\theta*$	FSDETA	CALCULATE SHOCK DETACHMENT ANGLE-OF-ATTACK ON FINS	DATCOM SECTION 4.1.3.3, PAGE 4.1.3.3-33 STEP 2B NACA 1135 EQN 138 & 168
X_{cp}	FWDXAC	CALCULATE FIN ALONE AERODYNAMIC CENTER FOR FORWARD SWEPT FINS	AFWAL TR-84-3084
η	GETETA	COMPUTE SUBSONIC CROSS FLOW DRAG PROPORTIONALITY FACTOR	AEDC-TR-75-124
	HYPER	COMPUTES PRESSURES BY MODIFIED NEWTONIAN THEORY	NASA TND-176
	KWBALP	DETERMINE RATIO K-W(B)/K-W(B)SBT DUE TO ANGLE OF ATTACK	EMPIRICAL CORRELATION OF TEST DATA (TEMPORARILY SET TO 1.0)
	LOADF	PRESSURE LOADING FUNCTIONS (DEJARNETTE)	AIAA JOURNAL OF SPACECRAFT, NOV-DEC 1980 P.529
C_N'	PANLCN	COMPUTES TOTAL FIN NORMAL FORCE OF A CRUCIFORM FIN SET USING THE CONCEPT OF EQUIVALENT ANGLE OF ATTACK	AIAA PAPER 77-1153 (NIELSON)
F-R S-R	SFWRW	COMPUTES SURFACE VORTEX LATERAL POSITION FOR LIFTING SURFACE/BODY VORTEX INTERFERENCE	NACA TR-1307 (PITTS, NIELSON, KAATARI)
θ_S	SHOCK	GET SHOCK SHAPE ANGLE FROM EQN.42 OF DEJARNETTE	AIAA JOURNAL OF SPACECRAFT, NOV-DEC 1980 P.529
C_F	SKINF	COMPUTES SKIN FRICTION DRAG USING VAN DRIEST METHOD II FOR TURBULENT FLOW AND BLAIUS FOR LAMINAR FLOW. EMPIRICAL CORRELATIONS ARE USED FOR TRANSITION AND SURFACE ROUGHNESS CALCULATIONS	MDAC-WEST AERODYNAMIC HANDBOOK (M 8.080-CD) DATCOM SECTION 4.1.5.1 FLUID DYNAMIC DRAG(HOERNER)
	SLOPE	COMPUTES SUBSONIC AIRFOIL SECTION LIFT CURVE SLOPE, AERODYNAMIC CENTER, AND CRITICAL MACH NUMBER	AFFDL-TR-71-87
	SOSE	PRESSURES BY MODIFIED NEWTONIAN AND IMPROVED 2ND ORDER SHOCK EXPANSION OF DEJARNETTE	AIAA JOURNAL OF SPACECRAFT, NOV-DEC 1980 P.529 (NSWC AERO CODE)
I_V	SURINT	COMPUTES INTERFERENCE FACTOR FOR VORTEX INTERACTION WITH LIFTING SURFACE	NACA TR-1307, APPENDIX B (PITTS, NIELSON, KAATARI)
	SVTRAK	COMPUTES WING VORTEX HORIZONTAL AND VERTICAL LOCATION AT CENTER OF PRESSURE	NACA TR-1307 (PITTS, NIELSON, KAATARI)
	VANDYK	COMPUTES SECOND ORDER AXIAL AND FIRST ORDER CROSS FLOW PERTURBATION VELOCITY COMPONENTS	NSWC AERO CODE
I_V	VRINTS	COMPUTES INTERFERENCE FACTOR FOR VORTEX INTERACTION WITH LIFTING SURFACE	NACA TR-1307, APPENDIX B (PITTS, NIELSON, KAATARI)
Ycp	YCP	SUBROUTINE TO COMPUTE LATERAL CENTER OF PRESSURE	AIAA PAPER 91-0708

5.4 COMMON BLOCK DEFINITIONS

This section summarizes the contents of each major common block within the program. If the block of data is input using namelist, the namelist name is noted. If the array can be dumped using the DUMP control card or written using the WRITE control card, the name is shown in the proper blank.

All data is stored in the foot-pound-second-degree-Rankine system of units regardless of the dimensional units set by the user. A data element is determined "unused" when the value of the number is equal to 1×10^{-30}. (See section 5.1.2 for a complete definition of UNUSED)

The blocks of data are listed alphabetically in this section according to their COMMON BLOCK names.

Table 8 AXIBOD Namelist Inputs (Common Block ABODIN)

DEFINITION OF COMMON BLOCK *ABODIN* (DUMP NAME *BDIN* , WRITE NAME *ABODIN*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	NX		Number of body stations	-
2	X0	X_0	Body apex station	ft
3-52	X	X	Longitudinal stations	ft
53-102	R	r	Radii	ft
103	TNOSE		Nose shape type	-
			0. = Conical or Cone	
			1. = Tangent ogive	
			2. = Power series	
			3. = Haack	
			4. = Von Karam	
104	LNOSE	L	Actual nose length	ft
105	DNOSE	D	Nose base diameter	ft
106	BNOSE	b	Nose bluntness radius	ft
107	TRUNC		.TRUE. if truncated	-
108	LCENTR	L	Centerbody length	ft
109	DCENTR	D	Centerbody base diameter	ft
110	TAFT		Afterbody shape type	-
			0. = Conical or Cone	
			1. = Ogive	
111	LAFT	L	Afterbody length	ft
112	DAFT	D	Afterbody base diameter	ft
113	POWER	n	Exponent for power series nose	-
114-133	DISCON		Indices of X stations where surface slope is discontinuous	-
134-183	ELLIP	e	Ellipticity of body at each X station	-
184-233	H	h	Height of body at each X station	ft
234	ENOSE	e_N	Nose base ellipticity	-
235	ECENTR	e_C	Centerbody base ellipticity	-
236	EAFT	e_a	Afterbody base ellipticity	-
237	DEXIT	d_{exit}	Nozzle exit diameter at base	ft

NOTE: Table continues on next page.

Table 8 AXIBOD Namelist Inputs (Common Block ABODIN) - Continued

DEFINITION OF COMMON BLOCK *ABODIN* (DUMP NAME *BDIN* , WRITE NAME *ABODIN*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
238	BASE		.TRUE. if jet interaction calculated	-
239	BETAN		Nozzle exit angle	deg
240-259	JMACH		Jet Mach number at nozzle exit	-
260-279	PRAT		Jet to freestream static pressure ratio	-
280-299	TRAT		Jet to freestream stagnation temperature ratio	-
300	PROTUB		.TRUE. if protuberance drag is calculated	-
301	NPROT		Number of protuberance sets	-
302-321	PTYPE		Protuberance set type: 1. = Vertical cylinder 2. = Horizontal cylinder 3. = Launch lug 4. = Launch shoe 5. = Block 6. = Fairing 7. = Component build (Not Used)	-
322-341	XPROT		Longitudinal distance from missile nose to protuberance set	ft
342-361	NLOC		Number of protuberances in each protuberance set	-
362-381	BLDMEM		Number of protuberance types in component build-up	-
382-481	BLDTYP		Types of protuberances in component build-up	-
482-581	LPROT		Length of each member or protuberance	ft
582-681	WPROT		Width of each member or protuberance	ft
682-781	HPROT		Height of each member or protuberance	ft
782-881	OPROT		Vertical offset of each member of protuberance	ft

Table 9 ELLBOD Namelist Inputs (Common Block ABODIN)

DEFINITION OF COMMON BLOCK *ABODIN* (DUMP NAME *BDIN* , WRITE NAME *ABODIN*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	NX		Number of body stations	-
2	X0	X_0	Body apex station	ft
3-52	X	X	Longitudinal stations	ft
53-102	R	r	Radii	ft
103	TNOSE		Nose shape type	-
			0. = Conical or Cone	
			1. = Tangent ogive	
			2. = Power series	
			3. = Haack	
			4. = Von Karam	
104	LNOSE	L	Actual nose length	ft
105	DNOSE	D	Nose base diameter	ft
106	BNOSE	b	Nose bluntness radius	ft
107	TRUNC		.TRUE. if truncated	-
108	LCENTR	L	Centerbody length	ft
109	DCENTR	D	Centerbody base diameter	ft
110	TAFT		Afterbody shape type	-
			0. = Conical or Cone	
			1. = Ogive	
111	LAFT	L	Afterbody length	ft
112	DAFT	D	Afterbody base diameter	ft
113	POWER	n	Exponent for power series nose	-
114-133	DISCON		Indices of X stations where surface slope is discontinuous	-
134-183	ELLIP	e	Ellipticity of body at each X station	-
184-233	H	h	Height of body at each X station	ft
234	ENOSE	e_N	Nose base ellipticity	-
235	ECENTR	e_C	Centerbody base ellipticity	-
236	EAFT	e_a	Afterbody base ellipticity	-
237	DEXIT	d_{exit}	Nozzle exit diameter at base	ft

NOTE: Table continues on next page.

Table 9 ELLBOD Namelist Inputs (Common Block ABODIN) - Continued

DEFINITION OF COMMON BLOCK *ABODIN*
(DUMP NAME *BDIN* , WRITE NAME *ABODIN*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
238	BASE		.TRUE. if jet interaction calculated	-
239	BETAN		Nozzle exit angle	deg
240-259	JMACH		Jet Mach number at nozzle exit	-
260-279	PRAT		Jet to freestream static pressure ratio	-
280-299	TRAT		Jet to freestream stagnation temperature ratio	-
300	PROTUB		.TRUE. if protuberance drag is calculated	-
301	NPROT		Number of protuberance sets	-
302-321	PTYPE		Protuberance set type:	-
			1. = Vertical cylinder	
			2. = Horizontal cylinder	
			3. = Launch lug	
			4. = Launch shoe	
			5. = Block	
			6. = Fairing	
			7. = Component build (Not Used)	
322-341	XPROT		Longitudinal distance from missile nose to protuberance set	ft
342-361	NLOC		Number of protuberances in each protuberance set	-
362-381	BLDMEM		Number of protuberance types in component build-up	-
382-481	BLDTYP		Types of protuberances in component build-up	-
482-581	LPROT		Length of each member or protuberance	ft
582-681	WPROT		Width of each member or protuberance	ft
682-781	HPROT		Height of each member or protuberance	ft
782-381	OPROT		Vertical offset of each member of protuberance	ft

Table 10 Body Aerodynamic Work Array (Common Block BDWORK)

DEFINITION OF COMMON BLOCK *BDWORK* (DUMP NAME *BDWK* , WRITE NAME *BDWORK*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	CNP	C_{N_P}	Potential normal force vs. α	-
21-40	CMP	C_{m_P}	Potential pitching moment vs. α	-
41-60	CNVIS	C_{N_V}	Viscous normal force vs. α	-
61-80	CMVIS	C_{m_V}	Viscous pitching moment vs. α	-
81-100	CAPR	$C_{A_{P,W}}$	Pressure/wave axial force vs. α	-
101-120	CAF	C_{A_f}	Friction axial force vs. α	-
121-140	CABASE	C_{A_b}	Base axial force vs. α	-
141	ETA	η	Cross-flow proportionality factor	-
142-161	CDC	C_{d_c}	Cross-flow drag coefficient vs. α	-
162-181	CAPROT		Protuberance axial force coefficient	-
182-201	BOTDCA		Boattail incremental axial force due to separation	-
202-221	BOTDCN		Boattail incremental normal force due to separation	-
222-241	BOTDCM		Boattail incremental pitching moment due to separation	-

Table 11 Case Identification (Common Block CASEID)

DEFINITION OF COMMON BLOCK *CASEID* (DUMP NAME , WRITE NAME *CASEID*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-74	IDCASE		Case I.D., one character per element	-
75	KOUNT		Number of saved namelists	-
76-175	NAMSV		Saved namelist order (packed 3 per element)	-
176	CASE		Case number	-
177	NOEXTR		.TRUE. if, no extrapolation messages	-
178	NOLAT		. TRUE . if no lat-dir derivatives to be computed	-
179	IR		Run number for plot file	-
180	IPAGE		Page number of output	-

Table 12 Program Constants (Common Block CONST)

DEFINITION OF COMMON BLOCK *CONST* (DUMP NAME , WRITE NAME *CONST*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	PI	π	Value for π	-
2	RAD		Value for $180/\pi$	-
3	UNUSED		Value for unused (1×10^{-30})	-
4	KAND		Namelist delimineter ($)	-

Table 13 Dynamic Derivatives for Body and Finset 1 (Common Block DB1)

DEFINITION OF COMMON BLOCK *DB1* (DUMP NAME *DB1* , WRITE NAME *DB1*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	T1CNQ	C_{N_q}	Normal force due to pitch vs. α	1/rad
21-40	T1CNAD	$C_{N_{\dot{\alpha}}}$	Normal force due to time rate of change of angle of attack vs. α	1/rad
41-60	T1PTCH	$C_{m_{\dot{\theta}}}$	Total damping in pitch vs. α	1/rad

Table 14 Dynamic Derivatives for Body and Finset 1,2 (Common Block DB12)

DEFINITION OF COMMON BLOCK *DB12*
(DUMP NAME *DB12* , WRITE NAME *DB12*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	T2CNQ	C_{N_q}	Normal force due to pitch vs. α	1/rad
21-40	T2CNAD	$C_{N_{\dot{\alpha}}}$	Normal force due to time rate of change of angle of attack vs. α	1/rad
41-60	T2PTCH	$C_{m_{\dot{\theta}}}$	Total damping in pitch vs. α	1/rad

Table 15 Dynamic Derivatives for Body and Finset 1,2,3 (Common Block DB123)

DEFINITION OF COMMON BLOCK *DB123* (DUMP NAME *DB13* , WRITE NAME *DB123*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	T3CNQ	C_{N_q}	Normal force due to pitch vs. α	1/rad
21-40	T3CNAD	$C_{N_{\dot{\alpha}}}$	Normal force due to time rate of change of angle of attack vs. α	1/rad
41-60	T3PTCH	$C_{m_{\dot{\theta}}}$	Total damping in pitch vs. α	1/rad

Table 16 Dynamic Derivatives for Body and Finset 1,2,3,4 (Common Block DB1234)

DEFINITION OF COMMON BLOCK *DB1234* (DUMP NAME *DB14* , WRITE NAME *DB1234*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	T4CNQ	C_{N_q}	Normal force due to pitch vs. α	1/rad
21-40	T4CNAD	$C_{N_{\dot{\alpha}}}$	Normal force due to time rate of change of angle of attack vs. α	1/rad
41-60	T4PTCH	$C_{m_{\dot{\theta}}}$	Total damping in pitch vs. α	1/rad

Table 17 Body Dynamic Derivatives (Common Block DBODY)

DEFINITION OF COMMON BLOCK *DBODY* (DUMP NAME *DBOD* , WRITE NAME *DBODY*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	BCNQ	C_{N_q}	Normal force due to pitch vs. α	1/rad
21-40	BCNAD	$C_{N_{\dot{\alpha}}}$	Normal force due to time rate of change of angle of attack vs. α	1/rad
41-60	BPTCH	$C_{m_{\dot{\theta}}}$	Total damping in pitch vs. α	1/rad
61	CLLP	C_{l_p}	Rolling moment due to roll rate	1/rad
62	CYP	C_{Y_p}	Side force due to roll rate	1/rad
63	CNP1		1st order yawing moment (magnus) coefficient	$1/\sin(\alpha)$
64	CNP3		3rd order yawing moment (magnus) coefficient	$1/\sin^3(\alpha)$
65	CNP5		5th order yawing moment (magnus) coefficient	$1/\sin^5(\alpha)$
66	CNPY5		5 degree secant slope of magnus moment coefficient (@ 5 degrees yaw)	$1/\sin(\alpha)$

Table 18 Finset 1 Dynamic Derivatives (Common Block DDFIN1)

DEFINITION OF COMMON BLOCK *DDFIN1* (DUMP NAME *DF1*, WRITE NAME *DFIN1*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	F1CNQ	C_{N_q}	Normal force due to pitch vs. α	1/rad
21-40	F1CNAD	$C_{N_{\dot{\alpha}}}$	Normal force due to time rate of change of angle of attack vs. α	1/rad
41-60	F1CMQ	C_{m_q}	Pitching moment due to pitch rate vs. α	1/rad
61-80	F1CMAD	$C_{m_{\dot{\alpha}}}$	Pitching moment due to time rate of change of angle of attack vs. α	1/rad

Table 19 Finset 2 Dynamic Derivatives (Common Block DDFIN2)

DEFINITION OF COMMON BLOCK *DDFIN2* (DUMP NAME *DF2* , WRITE NAME *DFIN2*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	F2CNQ	C_{N_q}	Normal force due to pitch vs. α	1/rad
21-40	F2CNAD	$C_{N_{\dot{\alpha}}}$	Normal force due to time rate of change of angle of attack vs. α	1/rad
41-60	F2CMQ	C_{m_q}	Pitching moment due to pitch rate vs. α	1/rad
61-80	F2CMAD	$C_{m_{\dot{\alpha}}}$	Pitching moment due to time rate of change of angle of attack vs. α	1/rad

Table 20 Finset 3 Dynamic Derivatives (Common Block DDFIN3)

DEFINITION OF COMMON BLOCK *DDFIN3* (DUMP NAME *DF3* , WRITE NAME *DFIN3*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	F2CNQ	C_{N_q}	Normal force due to pitch vs. α	1/rad
21-40	F2CNAD	$C_{N_{\dot{\alpha}}}$	Normal force due to time rate of change of angle of attack vs. α	1/rad
41-60	F2CMQ	C_{m_q}	Pitching moment due to pitch rate vs. α	1/rad
61-80	F2CMAD	$C_{m_{\dot{\alpha}}}$	Pitching moment due to time rate of change of angle of attack vs. α	1/rad

Table 21 Finset 4 Dynamic Derivatives (Common Block DDFIN4)

DEFINITION OF COMMON BLOCK *DDFIN4* (DUMP NAME *DF4*, WRITE NAME *DFIN4*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	F4CNQ	C_{N_q}	Normal force due to pitch vs. α	1/rad
21-40	F4CNAD	$C_{N_{\dot{\alpha}}}$	Normal force due to time rate of change of angle of attack vs. α	1/rad
41-60	F4CMQ	C_{m_q}	Pitching moment due to pitch rate vs. α	1/rad
61-80	F4CMAD	$C_{m_{\dot{\alpha}}}$	Pitching moment due to time rate of change of angle of attack vs. α	1/rad

Table 22 NACA Designation (Common Block DESIG)

DEFINITION OF COMMON BLOCK *DESIG* (DUMP NAME , WRITE NAME *DESIG*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-320	NNACA		NACA designation by fin set (80 each)	-

Table 23 Delete Flags for Input NAMELISTs (Common Block DFLAGS)

DEFINITION OF COMMON BLOCK *DFLAGS* (DUMP NAME , WRITE NAME *DFLAGS*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	DFLT		Delete prior $FLTCON flag	-
2	DREF		Delete prior $REFQ flag	-
3	DAXI		Delete prior $AXIBOD flag	-
4	DFIN1		Delete prior $FINSET1 flag	-
5	DFIN2		Delete prior $FINSET2 flag	-
6	DFIN3		Delete prior $FINSET3 flag	-
7	DFIN4		Delete prior $FINSET4 flag	-
8	DDEFL		Delete prior $DEFLCT flag	-
9	DTRIM		Delete prior $TRIM flag	-
10	DELLB		Delete prior $ELLBOD flag	-
11	DINLET		Delete prior $INLET flag	-
12	DARBOD		Delete prior $ARBBOD flag	-

Table 24 Dump Array Flags (Common Block DUMPF)

DEFINITION OF COMMON BLOCK *DUMPF*
(DUMP NAME , WRITE NAME *DUMPF*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	LGEOB		Flag to dump GEOBOD	-
2	LF1GM		Flag to dump GEOFS1	-
3	LF2GM		Flag to dump GEOFS2	-
4	LF3GM		Flag to dump GEOFS3	-
5	LF4GM		Flag to dump GEOFS4	-
6	LATMP		Flag to dump FLC and TOTALC	-
7	LBDWK		Flag to dump BDWORK	-
8	LFLCT		Flag to dump FLC	-
9	LINLD		Flag to dump INLTD	-
10	LINPT		Flag to dump input data	-
11	LFLTC		Flag to dump FLCT	-
12	LREFQN		Flag to dump REFQN	-
13	LBDIN		Flag to dump ABODIN or EBODIN	-
14	LF1IN		Flag to dump FSET1	-
15	LF2IN		Flag to dump FSET2	-
16	LF3IN		Flag to dump FSET3	-
17	LF4IN		Flag to dump FSET4	-
18	LINLEN		Flag to dump INLETN	-
19	LIOM		Flag to dump the I.O.M.	-
20	LSBOD		Flag to dump SBODY	-
21	LSF1		Flag to dump SFIN1	-
22	LSF2		Flag to dump SFIN2	-
23	LSF3		Flag to dump SFIN3	-
24	LSF4		Flag to dump SFIN4	-
25	LSB1		Flag to dump SB1	-
26	LSB12		Flag to dump SB12	-
27	LSB123		Flag to dump SB123	-
28	LS1234		Flag to dump SB1234	-
29	LBOD		Flag to dump DBODY	-
30	LDF1		Flag to dump DFIN1	-
31	LDF2		Flag to dump DFIN2	-
32	LDF3		Flag to dump DFIN3	-
33	LDF4		Flag to dump DFIN4	-
34	LDB1		Flag to dump DB1	-
35	LDB12		Flag to dump DB12	-
36	LDB123		Flag to dump DB123	-
37	LD1234		Flag to dump DB1234	-

Table 25 Finset 1 Aerodynamic Work Array (Common Block F1WORK)

DEFINITION OF COMMON BLOCK *F1WORK* (DUMP NAME *F1WK* , WRITE NAME *F1WORK*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	RHO1	ρ_{LE}	Panel effective L.E. radius	ft
2	TMAX1	$(t/c)_{MAX}$	Panel effective maximum t/c	-
3	KSHAR1	k	Wave drag parameter for section	-
4-23	CCLA1	$C_{l\alpha}$	Section $C_{l\alpha}$ vs. Mach	1/deg
24-43	XAC1	X_{ac}	Section X_{ac} vs. Mach	-
44-63	CMC041	$C_{m_{c/4}}$	Section C_m about c/4	-
64	CNALF1	$C_{N\alpha}$	Single panel $C_{N\alpha}$	1/deg
65-84	CNAAF1	$C_{N\alpha\alpha}$	Single panel $C_{N\alpha\alpha}$ vs. α	1/rad^2
85-104	CNLF1	C_{N_L}	Fin set linear C_N	-
105-124	CNNLF1	$C_{N_{NL}}$	Fin set non-linear C_N	-
125-144	CNF1AT	C_N	Fin set total C_N	-
145	XCPL1	X_{CP_L}	Single panel linear C.P.	ft
146	XCPNL1	$X_{CP_{NL}}$	Single panel non-linear C.P.	ft
147-166	CMFL1	C_{m_L}	Fin set linear C_m	-
167-186	CMFNL1	$C_{m_{NL}}$	Fin set non-linear C_m	-
187-206	CMF1AT	C_m	Fin set total Cm	-
207	CA0F1	C_{A_0}	Single panel C_{A_0}	-
208-227	CANLF1	$C_{A_{NL}}$	Single panel $(C_A-C_{A_0})$ vs α	-
228-247	ALPTF1	α_j	Interpolated α for panel char.	deg
248-267	CNFIT1	C_{N_j}	Interpolated C_N for panel char.	-
268	AI1	α_{ideal}	Ideal α for section	deg
269	AL01	α_{OL}	Zero lift α for section	deg
270	CLI1	CL_{ideal}	Ideal CL for section	-
271-290	CLM1	$C_{L_{max}}$	Maximum airfoil section C_L	-

Table 26 Finset 2 Aerodynamic Work Array (Common Block F2WORK)

DEFINITION OF COMMON BLOCK *F2WORK* (DUMP NAME *F2WK* , WRITE NAME *F2WORK*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	RHO2	ρ_{LE}	Panel effective L.E. radius	ft
2	TMAX2	$(t/c)_{MAX}$	Panel effective maximum t/c	-
3	KSHAR2	k	Wave drag parameter for section	-
4-23	CCLA2	C_{l_α}	Section C_{l_α} vs. Mach	1/deg
24-43	XAC2	X_{ac}	Section X_{ac} vs. Mach	-
44-63	CMC042	$C_{m_{c/4}}$	Section C_m about c/4	-
64	CNALF2	C_{N_α}	Single panel C_{N_α}	1/deg
65-84	CNAAF2	$C_{N_{\alpha\alpha}}$	Single panel $C_{N_{\alpha\alpha}}$ vs. α	$1/rad^2$
85-104	CNLF2	C_{N_L}	Fin set linear C_N	-
105-124	CNNLF2	$C_{N_{NL}}$	Fin set non-linear C_N	-
125-144	CNF2AT	C_N	Fin set total C_N	-
145	XCPL2	X_{CP_L}	Single panel linear C.P.	ft
146	XCPNL2	$X_{CP_{NL}}$	Single panel non-linear C.P.	ft
147-166	CMFL2	C_{m_L}	Fin set linear C_m	-
167-186	CMFNL2	$C_{m_{NL}}$	Fin set non-linear C_m	-
187-206	CMF2AT	C_m	Fin set total Cm	-
207	CA0F2	C_{A_0}	Single panel C_{A_0}	-
208-227	CANLF2	$C_{A_{NL}}$	Single panel $(C_A-C_{A_0})$ vs α	-
228-247	ALPTF2	α_j	Interpolated α for panel char.	deg
248-267	CNFIT2	C_{N_j}	Interpolated C_N for panel char.	-
268	AI2	α_{ideal}	Ideal α for section	deg
269	AL02	α_{OL}	Zero lift α for section	deg
270	CLI2	CL_{ideal}	Ideal CL for section	-
271-290	CLM2	$C_{L_{max}}$	Maximum airfoil section C_L	-

Table 27 Finset 3 Aerodynamic Work Array (Common Block F3WORK)

DEFINITION OF COMMON BLOCK *F3WORK* (DUMP NAME *F3WK* , WRITE NAME *F3WORK*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	RHO3	ρ_{LE}	Panel effective L.E. radius	ft
2	TMAX3	$(t/c)_{MAX}$	Panel effective maximum t/c	-
3	KSHAR3	k	Wave drag parameter for section	-
4-23	CCLA3	$C_{l\alpha}$	Section $C_{l\alpha}$ vs. Mach	1/deg
24-43	XAC3	X_{ac}	Section X_{ac} vs. Mach	-
44-63	CMC043	$C_{m_{c/4}}$	Section C_m about c/4	-
64	CNALF3	$C_{N\alpha}$	Single panel $C_{N\alpha}$	1/deg
65-84	CNAAF3	$C_{N\alpha\alpha}$	Single panel $C_{N\alpha\alpha}$ vs. α	$1/rad^2$
85-104	CNLF3	C_{N_L}	Fin set linear C_N	-
105-124	CNNLF3	$C_{N_{NL}}$	Fin set non-linear C_N	-
125-144	CNF3AT	C_N	Fin set total C_N	-
145	XCPL3	X_{CP_L}	Single panel linear C.P.	ft
146	XCPNL3	$X_{CP_{NL}}$	Single panel non-linear C.P.	ft
147-166	CMFL3	C_{m_L}	Fin set linear C_m	-
167-186	CMFNL3	$C_{m_{NL}}$	Fin set non-linear C_m	-
187-206	CMF3AT	C_m	Fin set total Cm	-
207	CA0F3	C_{A0}	Single panel C_{A0}	-
208-227	CANLF3	C_{ANL}	Single panel $(C_A - C_{A0})$ vs α	-
228-247	ALPTF3	α_j	Interpolated α for panel char.	deg
248-267	CNFIT3	C_{N_j}	Interpolated C_N for panel char.	-
268	AI3	α_{ideal}	Ideal α for section	deg
269	AL03	α_{OL}	Zero lift α for section	deg
270	CLI3	$C_{L_{ideal}}$	Ideal CL for section	-
271-290	CLM3	$C_{L_{max}}$	Maximum airfoil section C_L	-

Table 28 Finset 4 Aerodynamic Work Array (Common Block F4WORK)

DEFINITION OF COMMON BLOCK *F4WORK* (DUMP NAME *F4WK* , WRITE NAME *F4WORK*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	RHO4	ρ_{LE}	Panel effective L.E. radius	ft
2	TMAX4	$(t/c)_{MAX}$	Panel effective maximum t/c	-
3	KSHAR4	k	Wave drag parameter for section	-
4-23	CCLA4	C_{l_α}	Section C_{l_α} vs. Mach	1/deg
24-43	XAC4	X_{ac}	Section X_{ac} vs. Mach	-
44-63	CMC044	$C_{m_{c/4}}$	Section C_m about c/4	-
64	CNALF4	C_{N_α}	Single panel C_{N_α}	1/deg
65-84	CNAAF4	$C_{N_{\alpha\alpha}}$	Single panel $C_{N_{\alpha\alpha}}$ vs. α	$1/rad^2$
85-104	CNLF4	C_{N_L}	Fin set linear C_N	-
105-124	CNNLF4	$C_{N_{NL}}$	Fin set non-linear C_N	-
125-144	CNF4AT	C_N	Fin set total C_N	-
145	XCPL4	X_{CP_L}	Single panel linear C.P.	ft
146	XCPNL4	$X_{CP_{NL}}$	Single panel non-linear C.P.	ft
147-166	CMFL4	C_{m_L}	Fin set linear C_m	-
167-186	CMFNL4	$C_{m_{NL}}$	Fin set non-linear C_m	-
187-206	CMF4AT	C_m	Fin set total Cm	-
207	CA0F4	C_{A_0}	Single panel C_{A_0}	-
208-227	CANLF4	$C_{A_{NL}}$	Single panel $(C_A-C_{A_0})$ vs α	-
228-247	ALPTF4	α_j	Interpolated α for panel char.	deg
248-267	CNFIT4	C_{N_j}	Interpolated C_N for panel char.	-
268	AI3	α_{ideal}	Ideal α for section	deg
269	AL04	α_{OL}	Zero lift α for section	deg
270	CLI4	$C_{L_{ideal}}$	Ideal CL for section	-
271-290	CLM4	$C_{L_{max}}$	Maximum airfoil section C_L	-

Table 29 FLTCON Namelist Inputs (Common Block FLC)

DEFINITION OF COMMON BLOCK *FLC*
(DUMP NAME *FLT* , WRITE NAME *FLC*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	NALPHA		Number of angles of attack	-
2-21	ALPHA	α	Angles of attack	deg
22	BETA	β	Sideslip angle	deg
23	PHI	ϕ	Roll angle	deg
24	NMACH		Number of Mach numbers	
25-44	MACH	M	Mach numbers	-
45	ALT	h	Geometric altitude	ft
46-65	REN	R_e	Reynolds number	1/ft
66-85	VINF	V_∞	Free-stream velocity	ft/sec
86-105	TINF	T_∞	Free-stream temperature	°R
106-125	PINF	P_∞	Free-stream pressure	lb/ft^2

Table 30 FINSET1 Namelist Inputs (Common Block FSET1)

DEFINITION OF COMMON BLOCK *FSET1* (DUMP NAME *F1IN* , WRITE NAME *FSET1*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	SECTYP		Type of airfoil section 1. = NACA 0. = Hexagonal/diamond 2. = Circular arc 3. = User defined	-
2-11	SSPAN	$b/2$	Semi-span stations	ft
12-21	LMAXU	$(t/c)_{max_u}$	L.E. to max t/c, upper surface	-
22-31	LFLATU	l_u	Length of constant t/c, upper surface	-
31-41	LMAXL	$(t/c)_{max_l}$	L.E. to max, t/c, lower surface	-
42-51	LFLATL	l_l	Length of constant t/c, lower surface	-
52-61	CHORD	c	Chord length	ft
62-71	THICKU	$(t/c)_u$	t/c of upper section	-
72-81	THICKL	$(t/c)_l$	t/c of lower section	-
82-91	SWEEP	Λ	Sweep-back angle	deg
92-101	STA	η	Station for measuring sweep	-
102-111	XLE	X_{LE}	Station for L.E. of chord	ft
112	NPANEL		Number of panels	-
113-162	XCORD	X/c	X/c of section	-
163-212	MEAN	Y_m/c	Y/c of section (mean line)	-
213-262	THICK	t/c	t/c of section (thickness distribution)	-
263-312	YUPPER	Y_u	Y/c of upper surface	-
313-362	YLOWER	Y_l	Y/c or lower surface	-
363	FINPHI	ϕ	Roll angle of fins	deg
364-373	LER	r_{LE}	Fin L.E. radius	ft
374-381	GAM	Γ	Fin dihedral angle	deg
382-389	PHIF	ϕ_F	Fin ϕ from top vertical center	deg
390-399	CFOC	c_f/c	Flap chord to total chord ratio	-

Table 31 FINSET2 Namelist Inputs (Common Block FSET2)

DEFINITION OF COMMON BLOCK *FSET2*
(DUMP NAME *F2IN* , WRITE NAME *FSET2*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	SECTYP		Type of airfoil section 1. = NACA 0. = Hexagonal/diamond 2. = Circular arc 3. = User defined	-
2-11	SSPAN	b/2	Semi-span stations	ft
12-21	LMAXU	$(t/c)max_u$	L.E. to max t/c, upper surface	-
22-31	LFLATU	l_u	Length of constant t/c, upper surface	-
31-41	LMAXL	$(t/c)max_l$	L.E. to max, t/c, lower surface	-
42-51	LFLATL	l_l	Length of constant t/c, lower surface	-
52-61	CHORD	c	Chord length	ft
62-71	THICKU	$(t/c)_u$	t/c of upper section	-
72-81	THICKL	$(t/c)_l$	t/c of lower section	-
82-91	SWEEP	Λ	Sweep-back angle	deg
92-101	STA	η	Station for measuring sweep	-
102-111	XLE	X_{LE}	Station for L.E. of chord	ft
112	NPANEL		Number of panels	-
113-162	XCORD	X/c	X/c of section	-
163-212	MEAN	Y_m/c	Y/c of section (mean line)	-
213-262	THICK	t/c	t/c of section (thickness distribution)	-
263-312	YUPPER	Y_u	Y/c of upper surface	-
313-362	YLOWER	Y_l	Y/c or lower surface	-
363	FINPHI	ϕ	Roll angle of fins	deg
364-373	LER	r_{LE}	Fin L.E. radius	ft
374-381	GAM	Γ	Fin dihedral angle	deg
382-389	PHIF	ϕ_F	Fin ϕ from top vertical center	deg
390-399	CFOC	c_f/c	Flap chord to total chord ratio	-

Table 32 FINSET3 Namelist Inputs (Common Block FSET3)

DEFINITION OF COMMON BLOCK *FSET3*
(DUMP NAME *F3IN* , WRITE NAME *FSET3*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	SECTYP		Type of airfoil section 1. = NACA 0. = Hexagonal/diamond 2. = Circular arc 3. = User defined	-
2-11	SSPAN	$b/2$	Semi-span stations	ft
12-21	LMAXU	$(t/c)_{max_u}$	L.E. to max t/c, upper surface	-
22-31	LFLATU	l_u	Length of constant t/c, upper surface	-
31-41	LMAXL	$(t/c)_{max_l}$	L.E. to max, t/c, lower surface	-
42-51	LFLATL	l_l	Length of constant t/c, lower surface	-
52-61	CHORD	c	Chord length	ft
62-71	THICKU	$(t/c)_u$	t/c of upper section	-
72-81	THICKL	$(t/c)_l$	t/c of lower section	-
82-91	SWEEP	Λ	Sweep-back angle	deg
92-101	STA	η	Station for measuring sweep	-
102-111	XLE	X_{LE}	Station for L.E. of chord	ft
112	NPANEL		Number of panels	-
113-162	XCORD	X/c	X/c of section	-
163-212	MEAN	Y_m/c	Y/c of section (mean line)	-
213-262	THICK	t/c	t/c of section (thickness distribution)	-
263-312	YUPPER	Y_u	Y/c of upper surface	-
313-362	YLOWER	Y_l	Y/c or lower surface	-
363	FINPHI	ϕ	Roll angle of fins	deg
364-373	LER	r_{LE}	Fin L.E. radius	ft
374-381	GAM	Γ	Fin dihedral angle	deg
382-389	PHIF	ϕ_F	Fin ϕ from top vertical center	deg
390-399	CFOC	c_f/c	Flap chord to total chord ratio	-

Table 33 FINSET4 Namelist Inputs (Common Block FSET4)

DEFINITION OF COMMON BLOCK *FSET4* (DUMP NAME *F4IN* , WRITE NAME *FSET4*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	SECTYP		Type of airfoil section 1. = NACA 0. = Hexagonal/diamond 2. = Circular arc 3. = User defined	-
2-11	SSPAN	b/2	Semi-span stations	ft
12-21	LMAXU	$(t/c)_{max_u}$	L.E. to max t/c, upper surface	-
22-31	LFLATU	l_u	Length of constant t/c, upper surface	-
31-41	LMAXL	$(t/c)_{max_l}$	L.E. to max, t/c, lower surface	-
42-51	LFLATL	l_l	Length of constant t/c, lower surface	-
52-61	CHORD	c	Chord length	ft
62-71	THICKU	$(t/c)_u$	t/c of upper section	-
72-81	THICKL	$(t/c)_l$	t/c of lower section	-
82-91	SWEEP	Λ	Sweep-back angle	deg
92-101	STA	η	Station for measuring sweep	-
102-111	XLE	X_{LE}	Station for L.E. of chord	ft
112	NPANEL		Number of panels	-
113-162	XCORD	X/c	X/c of section	-
163-212	MEAN	Y_m/c	Y/c of section (mean line)	-
213-262	THICK	t/c	t/c of section (thickness distribution)	-
263-312	YUPPER	Y_u	Y/c of upper surface	-
313-362	YLOWER	Y_l	Y/c or lower surface	-
363	FINPHI	ϕ	Roll angle of fins	deg
364-373	LER	r_{LE}	Fin L.E. radius	ft
374-381	GAM	Γ	Fin dihedral angle	deg
382-389	PHIF	ϕ_F	Fin ϕ from top vertical center	deg
390-399	CFOC	c_f/c	Flap chord to total chord ratio	-

Table 34 Body Geometry Data (Common Block GEOBOD)

DEFINITION OF COMMON BLOCK *GEOBOD* (DUMP NAME *GEOB*, WRITE NAME *GEOBOD*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	SPNOSE	$(S_p)_N$	Nose section planform area	ft^2
2	SWNOSE	$(S_w)_N$	Nose section wetted area	ft^2
3	VOLNOS	V_N	Nose section volume	ft^3
4	XCVNOS	$(X_{C.V.})_N$	Nose section volume centroid	ft
5	XCPNOS	$(X_{C.P.})_N$	Nose section planform centroid	ft
6	FRNOSE	$(F_R)_N$	Nose Section fineness ratio	-
7	THEOLN	l_N^*	Nose section theoretical length	ft
8	THEOFN	F_{RN}^*	Nose section theoretical fineness ratio	-
9-16			Repeat of 1- 8 for centerbody	-
17-24			Repeat of 1-8 for aft body	-
25	SPLAN	S_p	Total planform area	ft^2
26	SWET	S_w	Total wetted area	ft^2
27	VOL	V	Total volume	ft^3
28	XCENTV	$X_{C.V.}$	Total volume centroid	ft
29	XCENTP	$X_{C.P.}$	Total planform centroid	ft
30	FR	F_R	Total fineness ratio	-
31	DBASE	d_b	Base diameter	ft
32	SBASE	S_b	Base area	ft^2
33	DMAX	d_{max}	Maximum diameter	ft
34	SMAX	S_{max}	Maximum cross-section area	ft^2
35	LTOTAL	l_T	Total body length	ft
36	BPNOSE	$(S_{pv})_N$	Vertical planform area of nose	ft^2
37	BCPNOS	$(X_{C.P._v})_N$	Vertical planform centroid of nose	ft
38	BPCENT	$(S_{pv})_C$	Vertical planform area of center body	ft^2
39	BCPCEN	$(X_{C.P._v})_C$	Vertical planform centroid of center body	ft
40	BPAFT	$(S_{pv})_A$	Vertical planform area of aft body	ft^2
41	BCPAFT	$(X_{C.P._v})_A$	Vertical planform centroid of aft body	ft
42	BPLAN	S_{pv}	Total vertical planform area	ft^2
43	BCENTP	$X_{C.P._v}$	Total vertical planform centroid	ft
44	ECSPN	$(S_{peqv})_N$	Equivalent circular nose planform area	ft^2
45	ECSPC	$(S_{peqv})_C$	Equivalent circular centerbody planform area	ft^2
46	ECSPA	$(S_{peqv})_A$	Equivalent circular aftbody planform area	ft^2
47	ECSPT	S_{peqv}	Total equivalent circular planform area	ft^2

Table 35 Finset 1 Geometry Data (Common Block GEOFS1)

DEFINITION OF COMMON BLOCK *GEOFS1* (DUMP NAME *FIGM* , WRITE NAME *GEOFS1*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-10	SPLANF	S_{p_i}	Planform area of segment	ft^2
11-20	CBAR	$\bar{c}_i$	Mean geometric chord of segment	ft
21-30	SWEPLE	$\Lambda_{L.E._i}$	Sweep angle at L . E . of segment	deg
31-40	SWEP25	$\Lambda_{.25c_i}$	Sweep angle at c/4 of segment	deg
41-50	SWEP50	$\Lambda_{.50c_i}$	Sweep angle at c/2 of segment	deg
51-60	SWEP75	$\Lambda_{.75c_i}$	Sweep angle at 3c/4 of segment	deg
61-70	SWEPTE	$\Lambda_{T.E._i}$	Sweep angle at T. E. of segment	deg
71-80	XMGCLE	$\bar{X}_{LE_i}$	Distance from c_r L.E. to M.G.C. of segment	ft
81-90	XMGC25	$\bar{X}_{.25c_i}$	Distance from c_r L.E. to .25 M.G.C. of segment	ft
91-100	XMGC50	$\bar{X}_{.50c_i}$	Distance from c_r L.E. to .50 M.G.C. of segment	ft
101-110	XMGC75	$\bar{X}_{.75c_i}$	Distance from c_r L.E. to .75 M.G.C. of segment	ft
111-120	XMGCTE	$\bar{X}_{TE_i}$	Distance from c_r L.E. to T.E. M.G.C. of segment	ft
121-130	YMEANC	$\bar{Y}_i$	Semi-span location of M.G.C. of segment	ft
131-140	ASPCT	AR_i	Aspect ratio of segment	-
141-150	TAPER	λ_i	Taper ratio of segment	-
151-160	TOVERC	t/c_i	Thickness to chord ratio of segment	-
161-170	XCENT	X_{c_i}	Planform area centroid station of segment	-
171	FINAR	AR	Panel aspect ratio (overall)	-
172	FINTPR	λ	Panel taper ratio (overall)	-
173	FINSPN	b/2	Panel exposed semi-span (overall)	ft
174	FINSP	S_p	Panel planform area (overall)	ft^2
175	FINWET	S_w	Panel wetted area (overall)	ft^2
176	TCEFF	$(t/c)_{eff}$	Panel effective t/c (overall)	-
177	FINXCG	X_{MGC}	Panel M.G.C. L.E. from root chord L.E.	ft
178	FINYCG	Y_{MGC}	Panel lateral M.G.C. position from C.L.	ft
179	SWAVLE	$\Lambda_{L.E.}$	Panel leading edge sweep, effective	deg
180	SWAV25	$\Lambda_{.25c}$	Panel c/4 sweep, effective	deg
181	SWAV50	$\Lambda_{.50c}$	Panel c/2 sweep, effective	deg
182	SWAV75	$\Lambda_{.75c}$	Panel 3c/4 sweep, effective	deg
183	SWAVTE	$\Lambda_{T.E.}$	Panel T.E. sweep, effective	deg
184	FINCBR	$\bar{c}$	Mean geometric chord	ft
185	DELTAY	Δy	Datcom parameter DY	-
186	DELTAD	δ_{LE}	Panel leading edge wedge angle	deg
187	XCENF	X_c	Panel area centroid from root chord L.E.	ft
188	XOVC	X/c	Axial position of section max thickness	-

Table 36 Finset 2 Geometry Data (Common Block GEOFS2)

DEFINITION OF COMMON BLOCK *GEOFS2*
(DUMP NAME *F2GM* , WRITE NAME *GEOFS2*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-10	SPLANF	S_{pi}	Planform area of segment	ft^2
11-20	CBAR	$\bar{c}_i$	Mean geometric chord of segment	ft
21-30	SWEPLE	$\Lambda_{L.E._i}$	Sweep angle at L . E . of segment	deg
31-40	SWEP25	$\Lambda_{.25c_i}$	Sweep angle at c/4 of segment	deg
41-50	SWEP50	$\Lambda_{.50c_i}$	Sweep angle at c/2 of segment	deg
51-60	SWEP75	$\Lambda_{.75c_i}$	Sweep angle at 3c/4 of segment	deg
61-70	SWEPTE	$\Lambda_{T.E._i}$	Sweep angle at T. E. of segment	deg
71-80	XMGCLE	$\bar{X}_{LE_i}$	Distance from c_r L.E. to M.G.C. of segment	ft
81-90	XMGC25	$\bar{X}_{.25c_i}$	Distance from c_r L.E. to .25 M.G.C. of segment	ft
91-100	XMGC50	$\bar{X}_{.50c_i}$	Distance from c_r L.E. to .50 M.G.C. of segment	ft
101-110	XMGC75	$\bar{X}_{.75c_i}$	Distance from c_r L.E. to .75 M.G.C. of segment	ft
111-120	XMGCTE	$\bar{X}_{TE_i}$	Distance from c_r L.E. to T.E. M.G.C. of segment	ft
121-130	YMEANC	$\bar{Y}_i$	Semi-span location of M.G.C. of segment	ft
131-140	ASPCT	AR_i	Aspect ratio of segment	-
141-150	TAPER	λ_i	Taper ratio of segment	-
151-160	TOVERC	t/c_i	Thickness to chord ratio of segment	-
161-170	XCENT	X_{c_i}	Planform area centroid station of segment	-
171	FINAR	AR	Panel aspect ratio (overall)	-
172	FINTPR	λ	Panel taper ratio (overall)	-
173	FINSPN	b/2	Panel exposed semi-span (overall)	ft
174	FINSP	S_p	Panel planform area (overall)	ft^2
175	FINWET	S_w	Panel wetted area (overall)	ft^2
176	TCEFF	$(t/c)_{eff}$	Panel effective t/c (overall)	-
177	FINXCG	X_{MGC}	Panel M.G.C. L.E. from root chord L.E.	ft
178	FINYCG	Y_{MGC}	Panel lateral M.G.C. position from C.L.	ft
179	SWAVLE	$\Lambda_{L.E.}$	Panel leading edge sweep, effective	deg
180	SWAV25	$\Lambda_{.25c}$	Panel c/4 sweep, effective	deg
181	SWAV50	$\Lambda_{.50c}$	Panel c/2 sweep, effective	deg
182	SWAV75	$\Lambda_{.75c}$	Panel 3c/4 sweep, effective	deg
183	SWAVTE	$\Lambda_{T.E.}$	Panel T.E. sweep, effective	deg
184	FINCBR	$\bar{c}$	Mean geometric chord	ft
185	DELTAY	Δy	Datcom parameter DY	-
186	DELTAD	δ_{LE}	Panel leading edge wedge angle	deg
187	XCENF	X_c	Panel area centroid from root chord L.E.	ft
188	XOVC	X/c	Axial position of section max thickness	-

Table 37 Finset 3 Geometry Data (Common Block GEOFS3)

DEFINITION OF COMMON BLOCK *GEOFS3*
(DUMP NAME *F3GM* , WRITE NAME *GEOFS3*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-10	SPLANF	S_{pi}	Planform area of segment	ft^2
11-20	CBAR	$\bar{c}_i$	Mean geometric chord of segment	ft
21-30	SWEPLE	$\Lambda_{L.E._i}$	Sweep angle at L . E . of segment	deg
31-40	SWEP25	$\Lambda_{.25c_i}$	Sweep angle at c/4 of segment	deg
41-50	SWEP50	$\Lambda_{.50c_i}$	Sweep angle at c/2 of segment	deg
51-60	SWEP75	$\Lambda_{.75c_i}$	Sweep angle at 3c/4 of segment	deg
61-70	SWEPTE	$\Lambda_{T.E._i}$	Sweep angle at T. E. of segment	deg
71-80	XMGCLE	$\bar{X}_{LE_i}$	Distance from c_r L.E. to M.G.C. of segment	ft
81-90	XMGC25	$\bar{X}_{.25c_i}$	Distance from c_r L.E. to .25 M.G.C. of segment	ft
91-100	XMGC50	$\bar{X}_{.50c_i}$	Distance from c_r L.E. to .50 M.G.C. of segment	ft
101-110	XMGC75	$\bar{X}_{.75c_i}$	Distance from c_r L.E. to .75 M.G.C. of segment	ft
111-120	XMGCTE	$\bar{X}_{TE_i}$	Distance from c_r L.E. to T.E. M.G.C. of segment	ft
121-130	YMEANC	$\bar{Y}_i$	Semi-span location of M.G.C. of segment	ft
131-140	ASPCT	AR_i	Aspect ratio of segment	-
141-150	TAPER	λ_i	Taper ratio of segment	-
151-160	TOVERC	t/c_i	Thickness to chord ratio of segment	-
161-170	XCENT	X_{c_i}	Planform area centroid station of segment	-
171	FINAR	AR	Panel aspect ratio (overall)	-
172	FINTPR	λ	Panel taper ratio (overall)	-
173	FINSPN	b/2	Panel exposed semi-span (overall)	ft
174	FINSP	S_p	Panel planform area (overall)	ft^2
175	FINWET	S_w	Panel wetted area (overall)	ft^2
176	TCEFF	$(t/c)_{eff}$	Panel effective t/c (overall)	-
177	FINXCG	X_{MGC}	Panel M.G.C. L.E. from root chord L.E.	ft
178	FINYCG	Y_{MGC}	Panel lateral M.G.C. position from C.L.	ft
179	SWAVLE	$\Lambda_{L.E.}$	Panel leading edge sweep, effective	deg
180	SWAV25	$\Lambda_{.25c}$	Panel c/4 sweep, effective	deg
181	SWAV50	$\Lambda_{.50c}$	Panel c/2 sweep, effective	deg
182	SWAV75	$\Lambda_{.75c}$	Panel 3c/4 sweep, effective	deg
183	SWAVTE	$\Lambda_{T.E.}$	Panel T.E. sweep, effective	deg
184	FINCBR	$\bar{c}$	Mean geometric chord	ft
185	DELTAY	Δy	Datcom parameter DY	-
186	DELTAD	δ_{LE}	Panel leading edge wedge angle	deg
187	XCENF	X_c	Panel area centroid from root chord L.E.	ft
188	XOVC	X/c	Axial position of section max thickness	-

Table 38 Finset 4 Geometry Data (Common Block GEOFS4)

DEFINITION OF COMMON BLOCK *GEOFS4*
(DUMP NAME *F4GM* , WRITE NAME *GEOFS4*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-10	SPLANF	S_{P_i}	Planform area of segment	ft^2
11-20	CBAR	$\bar{c}_i$	Mean geometric chord of segment	ft
21-30	SWEPLE	$\Lambda_{L.E._i}$	Sweep angle at L . E . of segment	deg
31-40	SWEP25	$\Lambda_{.25c_i}$	Sweep angle at c/4 of segment	deg
41-50	SWEP50	$\Lambda_{.50c_i}$	Sweep angle at c/2 of segment	deg
51-60	SWEP75	$\Lambda_{.75c_i}$	Sweep angle at 3c/4 of segment	deg
61-70	SWEPTE	$\Lambda_{T.E._i}$	Sweep angle at T. E. of segment	deg
71-80	XMGCLE	$\bar{X}_{LE_i}$	Distance from c_r L.E. to M.G.C. of segment	ft
81-90	XMGC25	$\bar{X}_{.25c_i}$	Distance from c_r L.E. to .25 M.G.C. of segment	ft
91-100	XMGC50	$\bar{X}_{.50c_i}$	Distance from c_r L.E. to .50 M.G.C. of segment	ft
101-110	XMGC75	$\bar{X}_{.75c_i}$	Distance from c_r L.E. to .75 M.G.C. of segment	ft
111-120	XMGCTE	$\bar{X}_{TE_i}$	Distance from c_r L.E. to T.E. M.G.C. of segment	ft
121-130	YMEANC	$\bar{Y}_i$	Semi-span location of M.G.C. of segment	ft
131-140	ASPCT	AR_i	Aspect ratio of segment	-
141-150	TAPER	λ_i	Taper ratio of segment	-
151-160	TOVERC	t/c_i	Thickness to chord ratio of segment	-
161-170	XCENT	X_{c_i}	Planform area centroid station of segment	-
171	FINAR	AR	Panel aspect ratio (overall)	-
172	FINTPR	λ	Panel taper ratio (overall)	-
173	FINSPN	b/2	Panel exposed semi-span (overall)	ft
174	FINSP	S_p	Panel planform area (overall)	ft^2
175	FINWET	S_w	Panel wetted area (overall)	ft^2
176	TCEFF	$(t/c)_{eff}$	Panel effective t/c (overall)	-
177	FINXCG	X_{MGC}	Panel M.G.C. L.E. from root chord L.E.	ft
178	FINYCG	Y_{MGC}	Panel lateral M.G.C. position from C.L.	ft
179	SWAVLE	$\Lambda_{L.E.}$	Panel leading edge sweep, effective	deg
180	SWAV25	$\Lambda_{.25c}$	Panel c/4 sweep, effective	deg
181	SWAV50	$\Lambda_{.50c}$	Panel c/2 sweep, effective	deg
182	SWAV75	$\Lambda_{.75c}$	Panel 3c/4 sweep, effective	deg
183	SWAVTE	$\Lambda_{T.E.}$	Panel T.E. sweep, effective	deg
184	FINCBR	$\bar{c}$	Mean geometric chord	ft
185	DELTAY	Δy	Datcom parameter DY	-
186	DELTAD	δ_{LE}	Panel leading edge wedge angle	deg
187	XCENF	X_c	Panel area centroid from root chord L.E.	ft
188	XOVC	X/c	Axial position of section max thickness	-

Table 39 Panel Incidence Data (Common Block INCID)

DEFINITION OF COMMON BLOCK *INCID* (DUMP NAME , WRITE NAME *INCID*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-8	DELTA1	δ_1	Panel deflections for fin set 1	deg
9-16	DELTA2	δ_2	Panel deflections for fin set 2	deg
17-24	DELTA3	δ_3	Panel deflections for fin set 3	deg
25-32	DELTA4	δ_4	Panel deflections for fin set 4	deg
33-36	XHINGE	X_{HL}	Station of panel hinge line for fin sets 1-4	ft
37-40	SKEW	Λ_{HL}	Hinge line skew for each panel, +aft	deg

Table 40 INLET Namelist Inputs (Common Block INLETN)

DEFINITION OF COMMON BLOCK *INLETN* (DUMP NAME *INLI* , WRITE NAME *INLETN*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	NIN		Number of inlets	-
2	INTYPE		Type of inlet 0 = 2 dimensional top mounted 1 = 2 dimensional side mounted 2 = axisymmetric	-
3	XINLT		Longitudinal distance from nose tip to inlet leading edge	ft
4	XDIV		Longitudinal distance from inlet leading edge to diverter leading edge	ft
5	HDIV		Height of diverter leading edge	ft
6	LDIV		Length of diverter	ft
7-26	PHI	ϕ	Inlet roll orientations	deg
27-31	XI		Inlet longitudinal positions relative to inlet leading edge	ft
32-36	HI		Inlet heights at the longitudinal positions	ft
37-41	WI		Inlet widths at the longitudinal positions	ft
42	ICOVER		if .TRUE. Inlets are covered	-
43	RAMANG		External compression ramp angle	deg
44	IAD		if .TRUE. Inlet additive drag is calculated	-
45-64	MFR		Mass flow ratio for each Mach number	-

Table 41 Inlet Incremental Aerodynamics (Common Block INLTD)

DEFINITION OF COMMON BLOCK *INLTD*
(DUMP NAME *INLD* , WRITE NAME *INLTD*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	CNINLT	C_{N_I}	Inlet increment for normal force coefficient	-
21-40	CMINLT	C_{m_I}	Inlet increment for pitching moment coefficient	-
41-60	CAINLT	C_{A_I}	Inlet increment for axial force coefficient	-
61-80	CYINLT	C_{Y_I}	Inlet increment for side force coefficient	-
81-100	CLNILT	C_{n_I}	Inlet increment for yawing moment coefficient	-

Table 42 Namelist Inputs Names (Common Block INPCON)

DEFINITION OF COMMON BLOCK *INPCON* (DUMP NAME , WRITE NAME *INPCON*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-11	LOC		Position of first letter for each name	-
12-22	LEN		Number of characters in each name	-
23-78	NLNAME		Namelist names valid as input	-

Table 43 Program Execution Logic Flags (Common Block LOGIC)

DEFINITION OF COMMON BLOCK *LOGIC* (DUMP NAME , WRITE NAME *LOGIC*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	LDMPCS		Dump case flag	-
2	LDAMP		Dynamic derivatives flag	-
3	LBUILD		Configuration buildup f lag	-
4	LNACA		NACA airfoil designation flag	-
5	LDERDG		Degree measure flag	-
6	LDERRD		Radian measure flag	-
7	LPART		Partial output flag	-
8	LNAME		Namelist print flag	-
9	LPLOT		Plot flag	-
10	LFLT		$FLTCON input flag	-
11	LREFQ		$REFQ input flag	-
12	LAXIS		$AXIBOD input flag	-
13	LFIN1		$FINSET1 input flag	-
14	LFIN2		$FINSET2 input flag	-
15	LFIN3		$FINSET3 input flag	-
16	LFIN4		$FINSET4 input flag	-
17	LDEFL		$DEFLCT input flag	-
18	LTRIM		$TRIM input flag	-
19	LDIMIN		Inches units flag	-
20	LDIMFT		Feet units flag	-
21	LDIMCM		Centimeters units flag	-
22	LDIMM		Meters units flag	-
23	LELLB		$ELLBOD input flag	-
24	LINLET		$INLET input flag	-
25	LEXPR		Experimental data input flag	-
26	LICRMT		Configuration incrementing flag	-
27	LSPIN		Body magnus coefficient flag	-
28	LARBOD		$ARBBOD input flag	-

NOTE: All flags are initially false. The flag is set if the array element is true.

Table 44 Partial Aerodynamic Coefficients (Common Block PAERO)

DEFINITION OF COMMON BLOCK *PAERO* (DUMP NAME , WRITE NAME *PAERO*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-4	AKBW	$K_{B(W)}$	Wing carryover on body	-
5-8	AKWB	$K_{W(B)}$	Body carryover on wing	-
9-12	AKKBW	$k_{B(W)}$	Wing incidence carryover on body	-
13-16	AKKWB	$k_{W(B)}$	Body incidence carryover on wing	-
17-20	XCPBW	$X_{cpB(W)}$	Body c.p. in presence of wing	-
21-24	XCPWB	$X_{cpW(B)}$	Wing c.p. in presence of body	-
25-664	DAQ	$\Delta\alpha_{EQ}$	Change in equivalent angle of attack	rad
665-1304	WAQ	α_{EQ}	Equivalent angle of attack	rad
1305-1944	CNW	C_{N_W}	Wing along normal for coefficient	-
1945-2584	CLW	C_{l_W}	Wing alone rolling moment	-
2585-2664	CNWB	$C_{N_{W(B)}}$	Wing (body) normal force coefficient	-
2665-2744	CMWB	$C_{m_{W(B)}}$	Wing (body) pitching moment coefficient	-
2745-2824	CAWB	$C_{A_{W(B)}}$	Wing (body) axial force coefficient	-
2825-2904	CYWB	$C_{Y_{W(B)}}$	Wing (body) side force coefficient	-
2905-2984	CSNWB	$C_{n_{W(B)}}$	Wing (body) yawing moment coefficient	-
2985-3064	CSLWB	$C_{l_{W(B)}}$	Wing (body) rolling moment coefficient	-
3065-3144	CNBW	$C_{N_{B(W)}}$	Body (wing) normal force coefficient	-
3145-3224	CMBW	$C_{m_{B(W)}}$	Body (wing) pitching moment coefficient	-
3225-3304	CABW	$C_{A_{B(W)}}$	Body (wing) axial force coefficient	-
3305-3384	CYBW	$C_{Y_{B(W)}}$	Body (wing) side force coefficient	-
3385-3464	CSNBW	$C_{n_{B(W)}}$	Body (wing) yawing moment coefficient	-
3465-3544	CSLBW	$C_{l_{B(W)}}$	Body (wing) rolling moment coefficient	-
3545-3624	CN	C_N	Total normal force coefficient	-
3625-3704	CM	C_m	Total pitching moment coefficient	-
3705-3784	CA	C_A	Total axial force coefficient	-
3785-3864	CY	C_Y	Total side force coefficient	-
3865-3944	CSN	C_n	Total yawing moment coefficient	-
3945-4024	CSL	C_l	Total rolling moment coefficient	-

Table 45 REFQ Namelist Inputs (Common Block REFQN)

DEFINITION OF COMMON BLOCK *REFQN* (DUMP NAME *REFQ*, WRITE NAME *REFQN*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	SREF	S_{ref}	Reference area	ft^2
2	LREF	$(L_{ref})_{lon}$	Longitudinal reference length	ft
3	LATREF	$(L_{ref})_{lat}$	Lateral reference length	ft
4	ROUGH	h*	Surface roughness height	in
5	XCG	$X_{C.G.}$	Longitudinal center of gravity	ft
6	ZCG	$Z_{C.G.}$	Vertical center of gravity	ft
7	SCALE		Vehicle scale factor	-
8	BLAYER		Boundary layer type 0. = turbulent 1. = natural transition	-
9	RHR		Surface roughness height rating [ROUGH = 3 x 10^{-6} (RHR)]	-

Table 46 Body and Finset 1 Ideal Output Matrix (I.O.M.) (Common Block SB1)

DEFINITION OF COMMON BLOCK *SB1* (DUMP NAME *SB1* , WRITE NAME *SB1*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	CN1	C_N	Normal force vs. α	-
21-40	CM1	C_m	Pitching moment vs. α	-
41-60	CA1	C_A	Axial force.vs. α	-
61-80	CY1	C_Y	Side force vs. α	-
81-100	CSN1	C_n	Yawing moment vs. α	-
101-120	CSL1	C_l	Rolling moment vs. α	-
121-140	CNA1	C_{N_α}	C_{N_α} vs. α	1/deg
141-160	CMA1	C_{m_α}	C_{m_α} vs. α	1/deg
161-180	CYB1	C_{Y_β}	C_{Y_β} vs. α	1/deg
181-200	CLNB1	C_{n_β}	C_{n_β} vs. α	1/deg
201-220	CLLB1	C_{l_β}	C_{l_β} vs. α	1/deg

Table 47 Body and Finset 1,2 I.O.M. (Common Block SB12)

DEFINITION OF COMMON BLOCK *SB12*
(DUMP NAME *SB12* , WRITE NAME *SB12*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	CN12	C_N	Normal force vs. α	-
21-40	CM12	C_m	Pitching moment vs. α	-
41-60	CA12	C_A	Axial force.vs. α	-
61-80	CY12	C_Y	Side force vs. α	-
81-100	CSN12	C_n	Yawing moment vs. α	-
101-120	CSL12	C_l	Rolling moment vs. α	-
121-140	CNA12	C_{N_α}	C_{N_α} vs. α	1/deg
141-160	CMA12	C_{m_α}	C_{m_α} vs. α	1/deg
161-180	CYB12	C_{Y_β}	C_{Y_β} vs. α	1/deg
181-200	CLNB12	C_{n_β}	C_{n_β} vs. α	1/deg
201-220	CLLB12	C_{l_β}	C_{l_β} vs. α	1/deg

Table 48 Body and Finset 1,2,3 I.O.M. (Common Block SB123)

DEFINITION OF COMMON BLOCK *SB123* (DUMP NAME *SB13*, WRITE NAME *SB123*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	CN13	C_N	Normal force vs. α	-
21-40	CM13	C_m	Pitching moment vs. α	-
41-60	CA13	C_A	Axial force.vs. α	-
61-80	CY13	C_Y	Side force vs. α	-
81-100	CSN13	C_n	Yawing moment vs. α	-
101-120	CSL13	C_l	Rolling moment vs. α	-
121-140	CNA13	C_{N_α}	C_{N_α} vs. α	1/deg
141-160	CMA13	C_{m_α}	C_{m_α} vs. α	1/deg
161-180	CYB13	C_{Y_β}	C_{Y_β} vs. α	1/deg
181-200	CLNB13	C_{n_β}	C_{n_β} vs. α	1/deg
201-220	CLLB13	C_{l_β}	C_{l_β} vs. α	1/deg

Table 49 Body and Finset 1,2,3,4 I.O.M. (Common Block SB1234)

DEFINITION OF COMMON BLOCK *SB1234*
(DUMP NAME *SB14* , WRITE NAME *SB1234*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	CN14	C_N	Normal force vs. α	-
21-40	CM14	C_m	Pitching moment vs. α	-
41-60	CA14	C_A	Axial force.vs. α	-
61-80	CY14	C_Y	Side force vs. α	-
81-100	CSN14	C_n	Yawing moment vs. α	-
101-120	CSL14	C_l	Rolling moment vs. α	-
121-140	CNA14	C_{N_α}	C_{N_α} vs. α	1/deg
141-160	CMA14	C_{m_α}	C_{m_α} vs. α	1/deg
161-180	CYB14	C_{Y_β}	C_{Y_β} vs. α	1/deg
181-200	CLNB14	C_{n_β}	C_{n_β} vs. α	1/deg
201-220	CLLB14	C_{l_β}	C_{l_β} vs. α	1/deg

Table 50 Body I.O.M. (Common Block SBODY)

DEFINITION OF COMMON BLOCK *SBODY* (DUMP NAME *SBOD*, WRITE NAME *SBODY*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	CN	C_N	Normal force vs. α	-
21-40	CM	C_m	Pitching moment vs. α	-
41-60	CA	C_A	Axial force.vs. α	-
61-80	CY	C_Y	Side force vs. α	-
81-100	CLN	C_n	Yawing moment vs. α	-
101-120	CLL	C_l	Rolling moment vs. α	-
121-140	CNA	C_{N_α}	C_{N_α} vs. α	1/deg
141-160	CMA	C_{m_α}	C_{m_α} vs. α	1/deg
161-180	CYB	C_{Y_β}	C_{Y_β} vs. α	1/deg
181-200	CLNB	C_{n_β}	C_{n_β} vs. α	1/deg
201-220	CLLB	C_{l_β}	C_{l_β} vs. α	1/deg

Table 51 Finset 1 I.O.M. (Common Block SFIN1)

DEFINITION OF COMMON BLOCK *SFIN1*
(DUMP NAME *SF1* , WRITE NAME *SFIN1*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	F1CN	C_N	Normal force vs. α	-
21-40	F1CM	C_m	Pitching moment vs. α	-
41-60	F1CA	C_A	Axial force.vs. α	-
61-80	F1CY	C_Y	Side force vs. α	-
81-100	F1CLN	C_n	Yawing moment vs. α	-
101-120	F1CLL	C_l	Rolling moment vs. α	-
121-140	F1CNA	C_{N_α}	C_{N_α} vs. α	1/deg
141-160	F1CMA	C_{m_α}	C_{m_α} vs. α	1/deg
161-180	F1CYB	C_{Y_β}	C_{Y_β} vs. α	1/deg
181-200	F1CLNB	C_{n_β}	C_{n_β} vs. α	1/deg
201-220	F1CLLB	C_{l_β}	C_{l_β} vs. α	1/deg

Table 52 Finset 2 I.O.M. (Common Block SFIN2)

DEFINITION OF COMMON BLOCK *SFIN2* (DUMP NAME *SF2*, WRITE NAME *SFIN2*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	F2CN	C_N	Normal force vs. α	-
21-40	F2CM	C_m	Pitching moment vs. α	-
41-60	F2CA	C_A	Axial force.vs. α	-
61-80	F2CY	C_Y	Side force vs. α	-
81-100	F2CLN	C_n	Yawing moment vs. α	-
101-120	F2CLL	C_l	Rolling moment vs. α	-
121-140	F2CNA	C_{N_α}	C_{N_α} vs. α	1/deg
141-160	F2CMA	C_{m_α}	C_{m_α} vs. α	1/deg
161-180	F2CYB	C_{Y_β}	C_{Y_β} vs. α	1/deg
181-200	F2CLNB	C_{n_β}	C_{n_β} vs. α	1/deg
201-220	F2CLLB	C_{l_β}	C_{l_β} vs. α	1/deg

Table 53 Finset 3 I.O.M. (Common Block SFIN3)

DEFINITION OF COMMON BLOCK *SFIN3*
(DUMP NAME *SF3* , WRITE NAME *SFIN3*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	F3CN	C_N	Normal force vs. α	-
21-40	F3CM	C_m	Pitching moment vs. α	-
41-60	F3CA	C_A	Axial force.vs. α	-
61-80	F3CY	C_Y	Side force vs. α	-
81-100	F3CLN	C_n	Yawing moment vs. α	-
101-120	F3CLL	C_l	Rolling moment vs. α	-
121-140	F3CNA	C_{N_α}	C_{N_α} vs. α	1/deg
141-160	F3CMA	C_{m_α}	C_{m_α} vs. α	1/deg
161-180	F3CYB	C_{Y_β}	C_{Y_β} vs. α	1/deg
181-200	F3CLNB	C_{n_β}	C_{n_β} vs. α	1/deg
201-220	F3CLLB	C_{l_β}	C_{l_β} vs. α	1/deg

Table 54 Finset 4 I.O.M. (Common Block SFIN4)

DEFINITION OF COMMON BLOCK *SFIN4*
(DUMP NAME *SF4* , WRITE NAME *SFIN4*)

LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	F4CN	C_N	Normal force vs. α	-
21-40	F4CM	C_m	Pitching moment vs. α	-
41-60	F4CA	C_A	Axial force.vs. α	-
61-80	F4CY	C_Y	Side force vs. α	-
81-100	F4CLN	C_n	Yawing moment vs. α	-
101-120	F4CLL	C_l	Rolling moment vs. α	-
121-140	F4CNA	C_{N_α}	C_{N_α} vs. α	1/deg
141-160	F4CMA	C_{m_α}	C_{m_α} vs. α	1/deg
161-180	F4CYB	C_{Y_β}	C_{Y_β} vs. α	1/deg
181-200	F4CLNB	C_{n_β}	C_{n_β} vs. α	1/deg
201-220	F4CLLB	C_{l_β}	C_{l_β} vs. α	1/deg

Table 55 Methodology Flags (Common Block THERY)

DEFINITION OF COMMON BLOCK *THERY* (DUMP NAME , WRITE NAME *THERY*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	LSOSE		.TRUE. if SOSE to be used	-
2	PRESUR		.TRUE. if pressure data to be output	-
3	LHYBRD		.TRUE. if Hybrid method to be used	-
4	LHYPER		.TRUE. if Newtonian theory to be used	-

Table 56 Configuration Total Attitude (Common Block TOTALC)

DEFINITION OF COMMON BLOCK *TOTALC* (DUMP NAME *FLCT* , WRITE NAME *TOTALC*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	BALPHA	α	Body axis angle of attack	deg
21-40	BBETA	β	Body axis sideslip angle	deg
41-60	BPHI	ϕ	Roll angle	deg
61-80	ALPTOT	α'	Total angle of attack	deg

Table 57 TRACE Subroutine Variables (Common Block TRACE)

DEFINITION OF COMMON BLOCK *TRACE* (DUMP NAME , WRITE NAME *TRACE*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	LEVEL		Program level	-
2-21	IROUTN		Routine names by level (2 locations per name, 10 levels)	-

Table 58 Trimmed Aerodynamic Data Arrays (Common Block TRIMD)

DEFINITION OF COMMON BLOCK *TRIMD* (DUMP NAME , WRITE NAME *TRIMD*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	DELTRM	δ_{TRIM}	δ_{TRIM} vs. α	deg
21-40	CNTRM	$C_{N_{TRIM}}$	$C_{N_{TRIM}}$ vs. α	-
41-60	CATRM	$C_{A_{TRIM}}$	$C_{A_{TRIM}}$ vs. α	-
61-80	CYTRM	$C_{Y_{TRIM}}$	$C_{Y_{TRIM}}$ vs. α	-
81-100	CLNTRM	$C_{n_{TRIM}}$	$C_{n_{TRIM}}$ vs. α	-
101-120	CLLTRM	$C_{l_{TRIM}}$	$C_{l_{TRIM}}$ vs. α	-

Table 59 Trim Inputs (Common Block TRIMIN)

DEFINITION OF COMMON BLOCK *TRIMIN* (DUMP NAME , WRITE NAME *TRIMIN*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1	SET		Fin set for trimming	-
2	PANL1		.TRUE. if used for trim	-
3	PANL2		.TRUE. if used for trim	-
4	PANL3		.TRUE. if used for trim	-
5	PANL4		.TRUE. if used for trim	-
6	PANL5		.TRUE. if used for trim	-
7	PANL6		.TRUE. if used for trim	-
8	PANL7		.TRUE. if used for trim	-
9	PANL8		.TRUE. if used for trim	-
10	DELMIN	δ_{min}	Minimum deflection angle	deg
11	DELMAX	δ_{max}	Maximum deflection angle	deg
12-19	ASYM		.TRUE. if panel is deflected asymmetric (reverses sign convention)	-

Table 60 Untrimmed Aerodynamic Data Arrays (Common Block UTRIMD)

DEFINITION OF COMMON BLOCK *UTRIMD* (DUMP NAME , WRITE NAME *UTRIMD*)				
LOCATION	VARIABLE NAME	ENGINEERING SYMBOL	DEFINITION	UNITS
1-20	CN	C_N	C_N vs. α for δ_1	-
21-40			C_N vs. α for δ_2	-
41-60			C_N vs. α for δ_3	-
61-80			C_N vs. α for δ_4	-
81-100			C_N vs. α for δ_5	-
101-120			C_N vs. α for δ_6	-
121-140			C_N vs. α for δ_7	-
141-160			C_N vs. α for δ_8	-
161-180			C_N vs. α for δ_9	-
181-200			C_N vs. α for δ_{10}	-
201-400	CM	C_m	C_m vs. α,δ (see C_N pattern)	-
401-600	CA	C_A	C_A vs. α,δ (see C_N pattern)	-
601-800	CY	C_v	C_Y vs. α,δ (see C_N pattern)	-
801-1000	CLN	C_n	C_n vs. α,δ (see C_N pattern)	-
1001-1200	CLL	C_l	C_l vs. α,δ (see C_N pattern)	-

A. EXAMPLE PROBLEMS

This appendix presents two example missile configurations that have been synthesized as Missile Datcom input files. These examples may be used as a model for the setup of inputs of similar configurations.

The first example is a simple tangent ogive nose-cylinder circular body. It has a planar wing (two panels) and a cruciform set of tails orientated in the "plus" configuration. There are two input cases for this problem. The first generates output consistent with the inclusion of the PART control card. The second creates trimmed output (note that trim partial output has been requested with the PRINT AERO TRIM control card).

The second problem is a body-tail-inlet configuration. Three Mach numbers are requested, one subsonic, one transonic, and one supersonic. Although all three Mach numbers could be run in a single case, they have been divided into three separate cases to illustrate the "SAVE" feature as well as selecting particular output for illustration.

A.1 EXAMPLE PROBLEM 1

The first example problem is shown in Figure A-1. It is comprised of a 3-caliber tangent ogive nose attached to a cylindrical body; a triangular monoplane set of wings; and a cruciform set of tails orientated in the "plus" position. The first case is a simple angle of attack sweep; component buildup data and partial output are requested. The second case is a trim of the configuration using the two horizontal tail surfaces. The inputs are shown in Figure A-2.

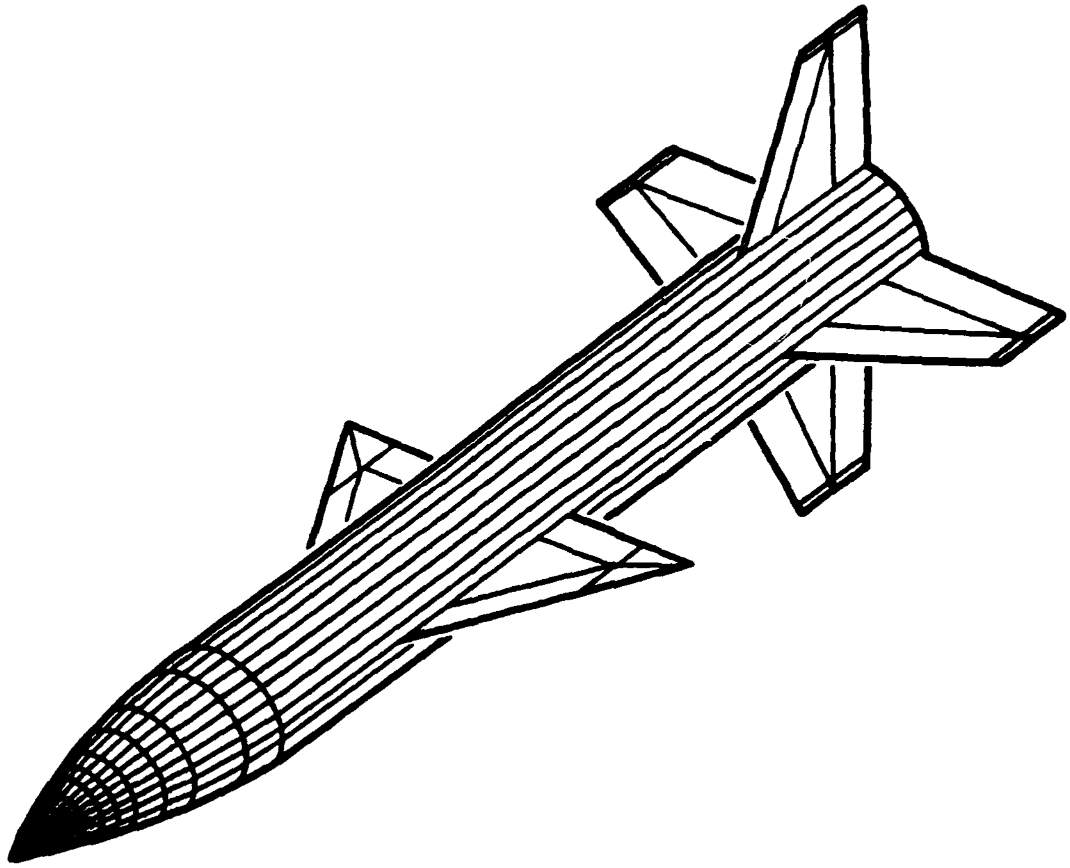


Figure A-1 Example Problem 1 Configuration

```
                    THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *
                    AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
                            CONERR - INPUT ERROR CHECKING

ERROR CODES - N* DENOTES THE NUMBER OF OCCURENCES OF EACH ERROR

A - UNKNOWN VARIABLE NAME

B - MISSING EQUAL SIGN FOLLOWING VARIABLE NAME

C - NON-ARRAY VARIABLE HAS AN ARRAY ELEMENT DESIGNATION - (N)

D - NON-ARRAY VARIABLE HAS MULTIPLE VALUES ASSIGNED

E - ASSIGNED VALUES EXCEED ARRAY DIMENSION

F - SYNTAX ERROR

   ******************************  INPUT DATA CARDS  ******************************

 1 CASEID PLANAR WING, CRUCIFORM PLUS TAIL CONFIGURATION
 2 DIM IN
 3 NO LAT
 4 BODE
 5  $FLTCON NMACH=1.,MACH=2.36,REN=3.0E6,
 6          NALPHA=8.,ALPHA=0.,4.,8.,12.,16.,20.,24.,28.,$
 7  $REFQ XCG=18.75,$
 8  $AXIBOD LNOSE=11.25,DNOSE=3.75,LCENTR=26.25,$
 9  $FINSET1 CHORD=6.96,0.,SSPAN=1.875,5.355,XLE=15.42,
10           SWEEP=0.,STA=1.,SUPPER=2*0.02238,
11           NPANEL=2.,PHIF=90.,270.,
12           LMAXU=0.238,LER=2*0.015,LFLATU=0.524,$
13  $FINSET2 CHORD=5.585,2.792,SSPAN=1.875,6.260,XLE=31.915,
14           SWEEP=0.,STA=1.,SUPPER=2*0.02238,
15           NPANEL=4.,PHIF=0.,90.,180.,270.,
16           LMAXU=0.288,LER=2*0.015,LFLATU=0.428,$
17 BUILD
18 PART
19 SAVE
20 NEXT CASE
21 CASEID TRIM OF CASE NUMBER 1
22  $TRIM SET=2.,$
23 PRINT AERO TRIM
24 NEXT CASE
```

Figure A-2 Example Problem 1 Input

A.2 EXAMPLE PROBLEM 2

The configuration for this example is sketched in Figures A-3 and A-4. The figure is a modified copy of the wind tunnel model drawings from NASA Technical Memorandum 84557. The model definition in these figures is representative of the detail normally found on design drawings.

This example has been divided into subsonic, transonic, and supersonic cases. Each case is run for one Mach number. Although all three Mach numbers could have been run in one case they were run separately to demonstrate the SAVE capability.

This example provides a check case for the inlet option. It can be used by the user to make sure that he understands the inputs. Figure A-5 shows the inputs required to run this example.

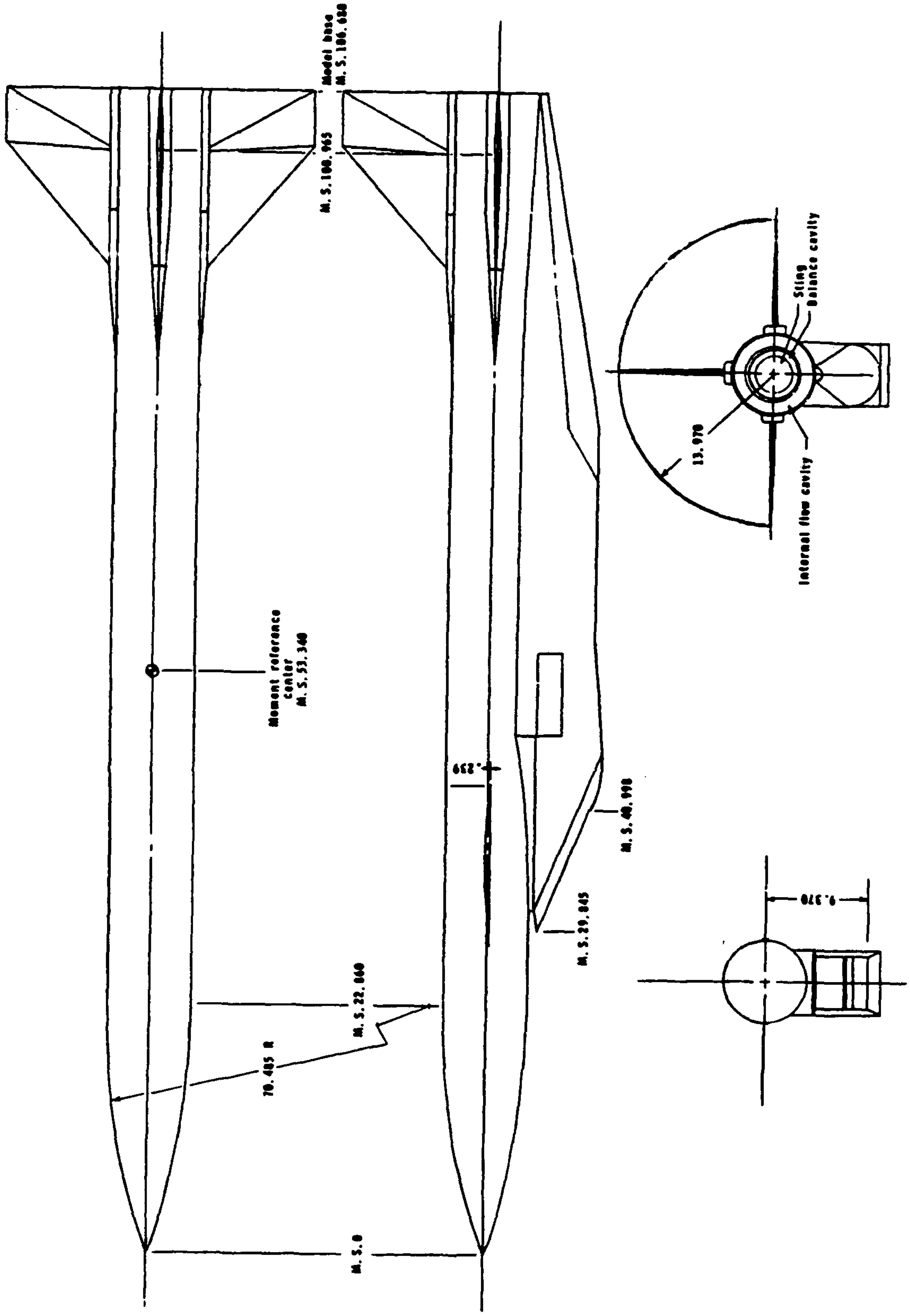
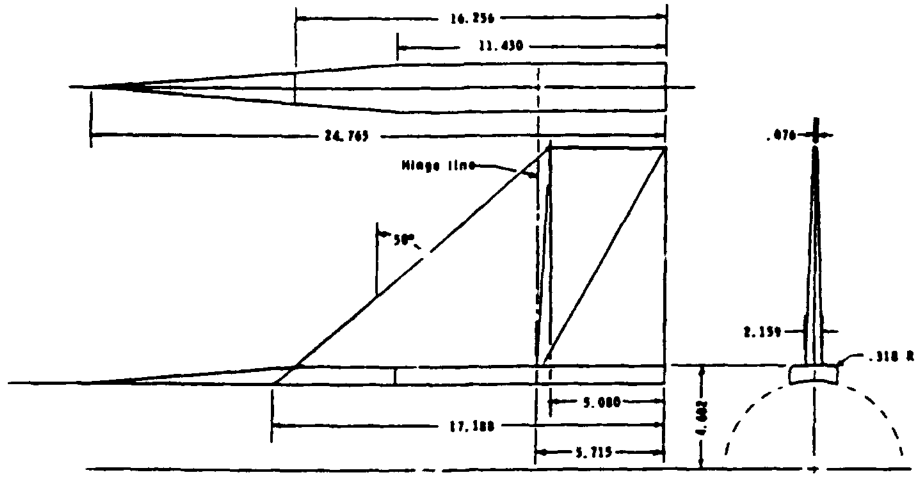
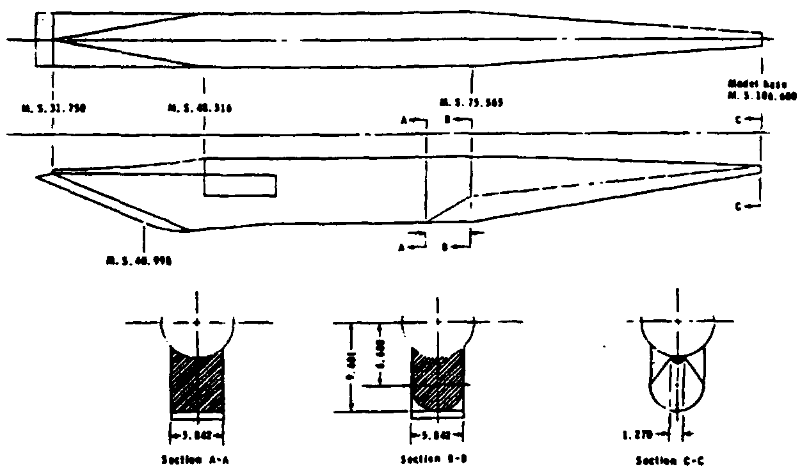


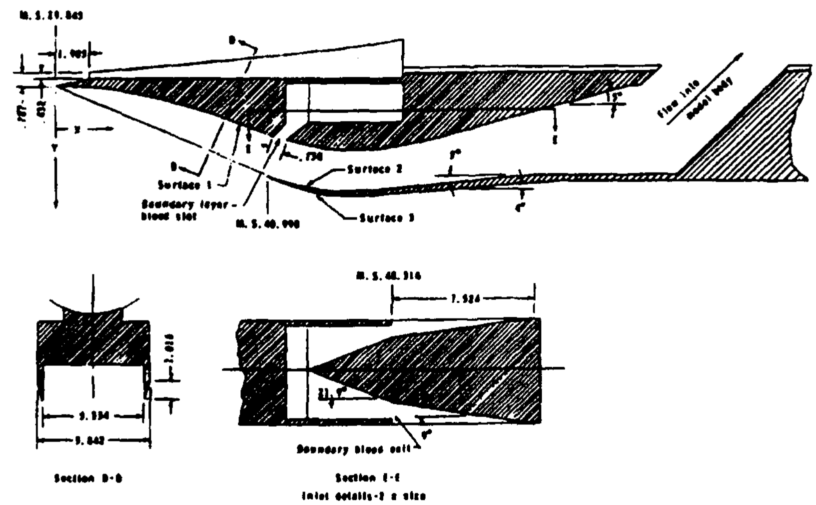
Figure A-3 Example Problem 2 Configuration



TAIL SURFACE DETAILS



INLET-FAIRING DETAILS



INLET DETAILS - 2X SIZE

Figure A-4 Example Problem 2 Tail/Inlet Details

```
                              THE USAF AUTOMATED MISSILE DATCOM * REV  4/91 *
                              AERODYNAMIC METHODS FOR MISSILE CONFIGURATIONS
                                   CONERR - INPUT ERROR CHECKING

ERROR CODES - N* DENOTES THE NUMBER OF OCCURENCES OF EACH ERROR

A - UNKNOWN VARIABLE NAME

B - MISSING EQUAL SIGN FOLLOWING VARIABLE NAME

C - NON-ARRAY VARIABLE HAS AN ARRAY ELEMENT DESIGNATION - (N)

D - NON-ARRAY VARIABLE HAS MULTIPLE VALUES ASSIGNED

E - ASSIGNED VALUES EXCEED ARRAY DIMENSION

F - SYNTAX ERROR

   ******************************  INPUT DATA CARDS  ******************************

 1 *
 2 * USE DEFAULT REFERENCE AREA AND LENGTH
 3 *
 4  $REFQ XCG=53.34,$
 5 *
 6 * DEFINE FLIGHT CONDITIONS
 7 *
 8  $FLTCON NMACH=1.,MACH=0.6,REN=6.5626,
 9          NALPHA=5.,ALPHA=0.,5.,10.,20.,25.,$
10 *
11 * DEFINE BODY
12 * NO BASE DRAG INCLUDED (DEXIT NOT INPUT)
13 *
14  $AXIBOD TNOSE=OGIVE,LNOSE=22.86,DNOSE=7.62,                                  ** SUBSTITUTING NUMERIC FOR NAME OGIVE
15          LCENTR=83.821,DCENTR=7.62,$
16 *
17 * DEFINE FINS
18 *
19  $FINSET1 SECTYP=HEX,SSPAN=4.062,13.97,CHORD=17.188,5.715,                    ** SUBSTITUTING NUMERIC FOR NAME HEX
20           XLE=89.492,SWEEP=0.,STA=1.,NPANEL=3.,PHIF=0.,90.,270.,
21           SUPPER=0.1256,0.,LFLATU=0.,1.,LMAXU=0.665,0.,$
```

Figure A-5 Example Problem 2 Input

```
*
* DEFINE INLET GEOMETRY
*
 $INLET  NIN=1.,INTYPE=2DTOP,XINLT=29.845,                    ** SUBSTITUTING NUMERIC FOR NAME 2DTOP
         XDIV=1.905,LDIV=16.566,HDIV=0.432,
         PHI=180.,
         X=0.,11.153,14.812,45.72,76.835,
         W=5.334,5.842,5.842,5.842,5.842,
         H=0.,5.128,5.359,5.359,0.635,
         COVER=.FALSE.,RAMP=15.0,$
*
* OPTIONS
*
CASEID MISSILE DATCOM EXAMPLE PROBLEM - SUBSONIC
SOSE
DIM CM
PART
SAVE
NEXT CASE
*
* CASE TWO - TRANSONIC
*
DELETE FLTCON
 $FLTCON NMACH=1.,MACH=1.0,REN=6.56E6,
         NALPHA=5.,ALPHA=0.,5.,10.,20.,25.,$
*
* OPTIONS
*
CASEID MISSILE DATCOM EXAMPLE PROBLEM - TRANSONIC
PRINT AERO HINGE
PRINT AERO BEND
SAVE
NEXT CASE
*
* CASE THREE - SUPERSONIC
*
DELETE FLTCON
 $FLTCON NMACH=1.,MACH=3.95,REN=6.56E6,
         NALPHA=5.,ALPHA=0.,5.,10.,20.,25.,$
*
* OPTIONS
*
CASEID MISSILE DATCOM EXAMPLE PROBLEM - SUPERSONIC
PRESSURES
NEXT CASE
```

Figure A-5 Example Problem 2 Input (Continued)

B. PLOT FILE FORMAT

When the PLOT control card is used, a formatted data file is written to unit 3. The first line in the file will be the word MISDAT. Lines with the following format will be repeated for each run:

LINE	COLUMN	CONTENT
1	1-4	Wo-d RUN
	5-7	For each case, a sequential run number beginning with one (1) and incrementing by one (1)
	8-10	Number of angles of attack
	11-14	word CASE
	15-17	A sequential run number beginning with one (1) and incrementing by one (1)
2	1-10	Mach Number
	11-22	Reynolds Number
	23-32	Aerodynamic roll angle, phi
	33-34	Units system: I-inches, F-feet, C-centimeters, M-meters
	35-41	I.D. Code (see below)
3	1-10	Reference Area
	11-20	Longitudinal Reference Length
	21-30	Longitudinal C.G. Location (X_{cg})
	31-40	Lateral Reference Length
	41-50	Vertical C.G. Location (Z_{cg})
4 (Repeated for each angle of attack)	1-10	Angle of Attack
	11-20	C_N or α_{TRIM}
	21-30	C_m or C_{NTRIM}
	31-40	C_A or C_{ATRIM}
	41-50	C_Y or C_{YTRIM}
	1-60	C_n or C_{nTRIM}
	1-70	C_l or C_{lTRIM}
LAST	1	Character R (denotes end of data for set)

The I.D. field identifies the configuration for which the data is applicable.

I.D. Code	Configuration/Condition
B	Body Alone
F1	Most forward fin set or fin set #1
F2	Second most forward fin set or fin set #2
F3	Third most forward fin set or fin set #3
F4	Fourth most forward fin set or fin set #4
BF1	Body plus most forward fin set
BF12	Body plus two most forward fin sets
BF13	Body plus three most forward fin sets
BF14	Body plus four most forward fin sets
TRIMMED	Trimmed results

Component buildup data is written to the file if the BUILD control card is used. If the TRIM control card is used, both the trimmed and untrimmed results are output. Otherwise, only the final configuration data is output. It is important to note that output via WRITE control cards is also written to unit 3.

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